elektor

up-to-date electronics for lab and leisure

D 71683

96

April 1983

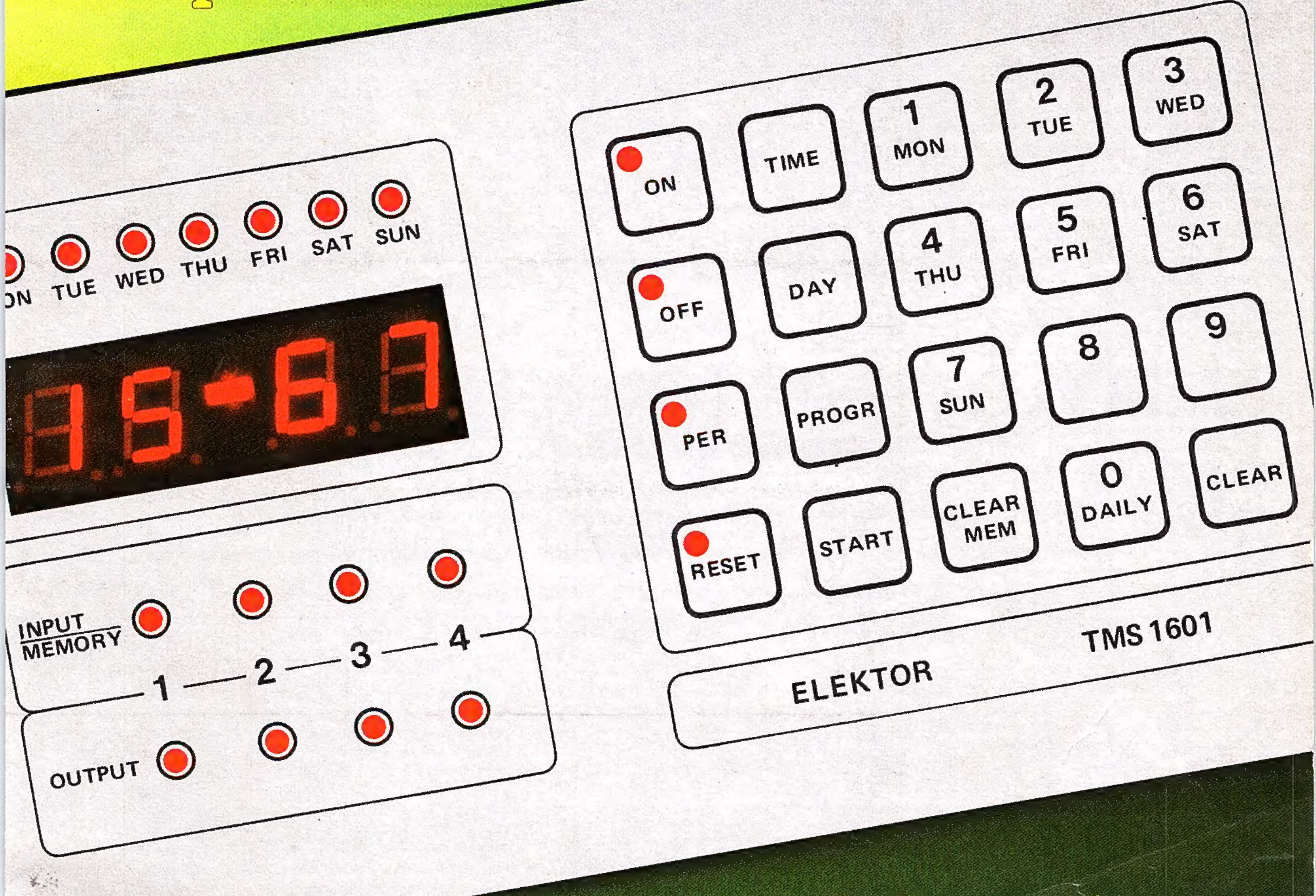
75 p.
IR 112p. (incl. VAT)
$ 2.50

Ron Tremayne

E8
$2.00 REC. AUST. RETAIL
$2.00 REC. AUST. RETAIL

Programmable timer/controller

The keyboard is part of the front panel!



darkroom timer

remote control audio

compact LCD thermometer

TTLs

7400	11p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	18p
7407	18p
7408	14p
7409	14p
7410	14p
7411	16p
7412	14p
7413	16p
7414	18p
7416	18p
7417	18p
7420	14p
7421	18p
7422	20p
7423	18p
7425	18p
7426	18p
7427	18p
7428	18p
7430	14p
7432	18p
7433	22p
7437	22p
7438	22p
7439	25p
7440	15p
7441	55p
7442A	30p
7443	70p
7444	70p
7445	50p
7446A	50p
7447A	36p
7448	45p
7450	15p
7451	15p
7453	15p
7454	15p
7460	15p
7470	30p
7472	25p
7473	25p
7474	18p
7475	22p
7476	25p
7480	48p
7481	120p
7482	65p
7483A	38p
7484	65p
7485	60p
7486	18p
7489	170p
7490A	20p
7491	35p
7492A	25p
7493A	24p
7494	35p
7495A	35p
7496	35p
7497	90p
74100	80p
74104	50p
74105	55p
74107	22p
74109	25p
74110	30p
74111	55p
74112	170p
74116	50p
74118	55p
74119	60p
74120	60p
74121	25p
74122	30p
74123	36p
74125	30p
74126	30p
74128	36p
74132	30p
74136	28p
74141	55p
74142	175p
74143	200p
74144	200p
74145	40p
74147	75p
74148	60p
74150	50p
74151A	36p
74153	36p
74154	50p
74155	40p
74156	36p
74157	30p
74159	75p
74160	40p
74161	40p
74162	40p
74163	40p
74164	45p
74165	45p
74166	48p
74167	150p
74170	120p
74172	250p
74173	50p
74174	55p
74175	50p
74176	40p
74177	45p
74178	70p
74180	40p
74181	115p
74182	40p
74184	90p
74185A	90p
74186	470p
74188	250p
74190	45p
74191	45p
74192	45p
74193	45p
74194	40p
74195	40p
74196	40p
74197	40p
74198	80p
74199	80p
74221	55p
74251	45p
74259	100p
74265	45p
74278	140p
74279	40p
74283	50p
74284	160p
74285	160p
74290	75p
74293	80p
74298	100p
74365A	30p
74366A	30p
74367A	30p
74368A	30p
74390	75p
74393	90p
74490	95p

74LS SERIES

74LS00	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS09	12p
74LS10	13p
74LS11	13p
74LS12	13p
74LS13	20p
74LS14	25p
74LS15	12p
74LS20	13p
74LS21	13p
74LS27	13p
74LS30	13p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	14p
74LS42	30p
74LS47	36p
74LS51	14p
74LS55	15p
74LS73	18p
74LS74	16p
74LS75	18p
74LS76	18p
74LS83	38p
74LS85	40p
74LS86	16p
74LS90	22p
74LS92	30p
74LS93	22p
74LS96	50p
74LS107	20p
74LS109	27p
74LS112	20p
74LS113	20p
74LS114	22p
74LS122	25p
74LS123	34p
74LS124	90p
74LS125A	24p
74LS126A	25p
74LS132	34p
74LS133	25p
74LS136	25p
74LS138	27p
74LS139	27p
74LS145	70p
74LS147	100p
74LS148	75p
74LS151	40p
74LS153	40p
74LS154	80p
74LS155	30p
74LS156	36p
74LS157	27p
74LS158	30p
74LS160A	36p
74LS161A	36p
74LS162A	36p
74LS163A	36p
74LS164	40p
74LS165A	50p
74LS166A	60p
74LS170	70p
74LS173A	55p
74LS174	40p
74LS175	40p
74LS181	90p
74LS190	36p
74LS191	36p
74LS192	36p
74LS193	36p
74LS194A	35p
74LS195A	35p
74LS196	45p
74LS197	45p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	55p
74LS245	75p
74LS247	70p
74LS248	55p
74LS249	55p
74LS251	30p
74LS253	30p
74LS256	150p
74LS257	30p
74LS258	35p
74LS259	55p
74LS266	20p
74LS273	55p
74LS279	30p
74LS283	40p
74LS293	40p
74LS299	180p
74LS321	150p
74LS323	160p
74LS324	150p
74LS348	90p
74LS352	60p
74LS353	60p
74LS363	140p
74LS364	140p
74LS365A	30p
74LS367A	30p
74LS368A	30p
74LS373	55p
74LS374	55p
74LS375	45p
74LS377	70p
74LS378	70p
74LS390	45p
74LS393	45p
74LS399	160p
74LS445	100p
74LS540	90p
74LS541	80p
74LS610	£19
74LS626	150p
74LS628	150p
74LS640	100p
74LS641	100p
74LS642	100p
74LS643	100p
74LS644	100p
74LS668	100p
74LS669	100p
74LS670	120p
74LS682	300p
74LS684	300p
74LS687	£400p

74C SERIES

74C244	160p
74C245	180p
74C373	160p
74C374	160p

4000 CMOS

4000	10p
4001	10p
4002	12p
4006	50p
4007	14p
4008	36p
4009	24p
4010	24p
4011	11p
4012	16p
4013	20p
4014	48p
4015	40p
4016	20p
4017	32p
4018	45p
4019	25p
4020	48p
4021	40p
4022	45p
4023	13p
4024	32p
4025	13p
4026	80p
4027	20p
4028	40p
4029	45p
4030	15p
4031	125p
4033	125p
4034	140p
4035	45p
4036	275p
4037	110p
4038	110p
4039	290p
4040	40p
4041	40p
4042	40p
4043	40p
4044	40p
4045	105p
4046	50p
4047	45p
4048	50p
4049	24p
4050	24p
4051	45p
4052	60p
4053	50p
4054	90p
4055	90p
4056	90p
4059	450p
4060	55p
4063	90p
4066	27p
4067	225p
4068	14p
4069	14p
4070	14p
4071	14p
4072	14p
4073	14p
4075	14p
4076	48p
4077	16p
4081	14p
4082	15p
4086	40p
4089	125p
4093	24p
4094	90p
4095	75p
4096	70p
4097	290p
4098	90p
4099	100p
40100	200p
40101	130p
40102	140p
40103	170p
40104	90p
40105	110p
40106	36p
40107	60p
40108	450p
40109	100p
40110	275p
40114	225p
40244	160p
40245	180p
40257	160p
4502	60p
4503	45p
4507	35p
4508	130p
4510	45p
4511	45p
4512	48p
4514	110p
4515	110p
4516	55p
4518	40p
4519	30p
4520	50p
4521	90p
4526	60p
4527	60p
4528	50p
4531	125p
4532	70p
4534	400p
4536	270p
4538	90p
4539	70p
4541	70p
4543	75p
4553	245p
4555	35p
4556	35p
4557	300p
4560	120p
4566	160p
4568	250p
4569	170p
4572	30p
4583	90p
4584	36p
4585	75p
4599	290p
4724	150p
40014	40p
40085	90p
40097	45p
14411	675p
14412	800p
14433	1100p
14495	300p
14500	575p
14599	290p
CD22100	350p
CD22101	700p
CD22102	700p

COUNTERS

74C925	400p
74C928	600p
ICM7216B	2000p
ICM7217A	850p
MK50398N	750p
ZN1040E	670p

TTL & ECL

10116	70p
10231	350p

LINEAR I.Cs

AY1 0212	600p	MF10CN	250p
AY1 5050	99p	MK50398	750p
AY3 8910	380p	MK50240	£9
AY3-8912	625p	ML920	800p
AY5-4007D	600p	MM57160	620p
CA3019	80p	NE531	140p
CA3028A	120p	NE555	16p
CA3046	70p	NE556	45p
CA3080E	70p	NE564	420p
CA3086	48p	NE565	120p
CA3089E	200p	NE566	155p
CA3090AQ	375p	NE567	140p
CA3130E	90p	NE571	400p
CA3140E	40p	NE5534A	250p
CA3160E	100p	RC4136	60p
CA3161E	150p	RC4151	200p
CA3162E	450p	S566B	225p
CA3189E	300p	SAA1900	£16
DAC1408-8	200p	SAD1024A	900p
HA1388	250p	SFF96364	800p
ICL7106	700p	SL490	350p
ICL8038	300p	SN76477	450p
LF351	48p	SP8515	750p
LF356P	95p	TA7205	90p
LM10C	325p	TAA550	50p
LM301A	25p	TAA621	275p
LM308N	75p	TBA641BX1	400p
LM310	120p	TBA800	80p
LM311	70p	TBA810	100p
LM318	150p	TBA820	80p
LM319	215p	TBA950	225p
LM324	30p	TC9109	750p
LM339	50p	TCA210	350p
LM348	65p	TCA220	350p
LM358P	60p	TCA440	220p
LM377	175p	TCA940	175p
LM380	75p	TDA1004A	300p
LM381AN	180p	TDA1008	320p
LM386	90p	TDA1010	200p
LM387	120p	TDA1022	500p
LM389	95p	TDA1024	120p
LM393	100p	TDA1034B	250p
LM394CH	300p	TDA1170	300p
LM709	36p	TDA2002V	300p
LM710	50p	TDA2020	320p
LM711	70p	TLO71/81	25p
LM733	60p	TLO72/82	45p
LM741	18p	TLO74	100p
LM747	70p	TLO83	75p
LM748	35p	TLO84	90p
LM1886	700p	TLO94	200p
LM1889	350p	TL170	50p
LM2917	200p	TMS1601	£12
LM3900	50p	UAA170	170p
LM3909	85p	ULN2003	108p
LM3911	125p	XR2206	300p
LM3914	200p	ZN414	80p
LM3915	200p	ZN419C	190p
LM3916	225p	ZN424E	130p
LM13600	110p	ZN425E	340p
MB3712	200p	ZN426E	300p
MC1310P	150p	ZN427E	590p
MC1458	36p	ZN428E	400p
MC1495L	350p	ZN1034E	200p
MC1496	70p	ZN1040E	670p
MC3340P	120p	ZNA234	850p
MC3401	50p	ZNA134	£23
MC3403	65p		

CPU's

1802CE	650p
2650A	1200p
6502	350p
6800	225p
6802	250p
6809	650p
INS8060	1100p
8080A	250p
8085A	450p
8088	£18
Z80	290p
Z80A	320p
Z80B	£12
TMS995	£12

SUPPORT DEVICES

3242	800p
6522	350p
6532	550p
6551	650p
6821	100p
6850	110p
6852	250p
8205	225p
8212	110p
8216	100p
8224	200p
8228	220p
8251	250p
8253	390p
8255	250p
8257	400p
8259	400p
8271	£36
8279	440p
Z80P10	250p
Z80AP10	280p
Z80CTC	250p
Z80SIO 1/2/3	£9

MEMORIES

2101 4L	400p
2102 2L	120p
2107B	500p
2111 4L	300p
2112	300p
2114L	90p
2114L 2	95p
2147	400p
4027	300p
4116L 2	90p
4118	400p
4164	400p
4816AP 3	280p
5101L	300p
6116P 3	420p
6116LP 3	550p
6514	200p
6810	120p

PROMS

71301	700p
74S188	275p
74S201	350p
74S287	350p
74S387	350p
74S470	600p
74S471	600p
74S571	650p
74S573	900p
82S123	300p
82S137	750p
93427	400p
93436	650p
93446	650p
93448	900p

BAUD RATE GENERATOR

COM8116	700p
MC14411	675p

EPROMS

2516	250p
2564	£12
2708	250p
2716	250p
2532	375p
2732	450p
2716 300nS	500p
2732 300nS	750p
2764	£11

MODULATORS

6MHz UHF	375p
8MHz UHF	450p

UARTS

AY 5 1013P	300p
AY 5 1015P	300p
IM6402	450p
TR1602	300p
COM 8017	300p

CRT CONTROLLER

CRT 5027	£18
CRT 5037	£18
CRT 6545	900p
MC6845	650p
MC6847	£10
SFF96364	£8
9365	£48
EF9366	£48
TMS9927	£18
TMS9928	£20
TMS9929	£20

CHARACTER GEN.

RO-3-2513U.C.	750p
RO-3-2513L.C.	700p
SN74S262AN	£10

CRYSTALS

100KHz	250p
200KHz	280p
1MHz	290p
1 008MHz	275p
1 843MHz	210p
1 89MHz	300p
2 0MHz	225p
2 457MHz	210p
3 276MHz	150p
3 57945MHz	100p
4.0MHz	150p
4 19MHz	200p
4 43MHz	110p
5.068MHz	200p
6.0MHz	150p
7 0MHz	150p
8.0MHz	175p
8.867MHz	175p
10.7MHz	150p
15.0MHz	200p
17.7MHz	200p
18MHz	200p
24.00 MHz	200p
26.690MHz	150p
27.145MHz	200p

KEYBOARD ENCODER

AY-5-2376	700p
74C 922N	420p

TELETEXT DECODER

SAA5020	£6
SAA5030	£9
SAA5041	£16
SAA5050	£9
EF9340	700p
EF9341	700p

INTERFACE ICS

AD558	775p
AD561J	£20
AD7581	1150p
DM8131	275p
DP8304	250p
DS8835	200p
DS8836	150p
DS8838	225p
MC1488	55p
MC1489	55p
MC3446	300p
MC3480	850p
MC3486	500p
MC3487	300p
75107	90p
75110	90p
75150P	120p
75154	140p
75182	90p
75324	375p
75361	150p
75363	150p
75365	150p
75451/2	72p
75491/2	65p
8T26	120p
8T28	120p
8T95/96	90p
8T97/98	90p
9601	220p
9602	220p
9637AP	160p
ZN425E-8	350p
ZN426E-8	350p
ZN427E-8	600p
ZN428E-8	450p

LOW PROFILE DIL SOCKETS BY TEXAS

8 pin	9p	18 pin	16p	24 pin	24p
14 pin	10p	20 pin	18p	28 pin	26p
16 pin	11p	22 pin	22p	40 pin	30p

WIRE WRAP SOCKETS BY TEXAS

8 pin	30p	18 pin	50p	24 pin	70p
14 pin	35p	20 pin	60p	28 pin	80p
16 pin	40p	22 pin	65p	40 pin	100p

JUMPER LEADS

24" Ribbon cable with DIP Headers

	14 pin	16 pin	24 pin	40 pin
Single End	145p	165p	240p	380p
Double End	210p	230p	345p	540p

24" Ribbon cable with sockets

	20 pin	26 pin	34 pin	40 pin
Single End	160p	210p	270p	340p
Double End	290p	385p	490p	540p

24" Ribbon cable with edge conn.

	20 way	34 way	40 way	50 way
Single End	275p	525p	600p	650p

24" Cable with 25 way D Connector

Male **500p** Female **540p**

IDC CONNECTORS

	10 way	20 way	26 way	34 way	40 way
Header Plug	90p	150p	200p	240p	270p
Receptacle	90p	165p	200p	240p	270p
Edge Conn	200p	250p	320p	380p	560p

EURO CONNECTORS

		Plug	Socket
DIN 41612	2 · 32-way	300p	350p
angled	2 · 32-way	350p	400p
angled	3 · 32-way	400p	—
(for 2 · 32 way specify a · b or a · c)			
DIN 41617	31-way	200p	200p

MIN. D CONNECTORS

	9 way	15 way	25 way	37 way
MALE				
solder	95p	135p	200p	280p
angled	160p	230p	265p	425p
FEMALE				
solder	125p	190p	245p	375p
angled	175p	240p	310p	500p
hood (top/side entry)	100p	100p	100p	150p

25 way Centronix Type Conn. **£6.50**
37 way Centronix Type conn. **£6.50**

VOLTAGE REGULATORS
Fixed Plastic TO-220

1A	+ve		−ve	
5v	7805	40p	7905	45p
6v	7806	40p	7906	45p
8v	7808	40p	7908	45p
12v	7812	40p	7912	45p
15v	7815	40p	7915	45p
18v	7818	40p	7918	45p
24v	7824	40p	7924	45p

100mA +ve		TO-92	
5v 78L05	30p	79L05	50p
12v 78L12	30p	79L12	50p
15v 78L15	50p	79L15	50p

OTHER REGULATORS

LM309K	140p		
LM317T	200p	78MGT2C	140p
LM323K	450p	79GUIC	225p
LM723	30p	79HGKC	650p
78GUIC	200p	78PO5	900p
78HO5	550p	RC4195NB	150p
78HGKC	600p	TL494	300p

OPTO-ELECTRONICS

2N5777	40p	ORP60	120p
OCP71	250p	ORP61	120p
ORP12	90p	TIL78	55p
TIL32	55p		

OPTO-ISOLATORS

ILD74	130p	TIL111	70p
MCT6	160p	TIL112	70p
MOC3020	150p	TIL 113	70p
MSC2400	190p	TIL116	70p

LEDS

0.125"		0.2"	
TIL220 Red	10p	TIL209 Red	10p
TIL222 Gr	12p	TIL212 Ye	15p
TIL228 Ye	15p	TIL211 Gr	12p
Rectangular		LEDS (R, G, Y)	30p

DISPLAYS

DL 704	140p	NSB5881	570p
DL 707 Red	140p	TIL311	600p
DL 707 Gr	140p	TIL312/3	110p
DL 747 Red	225p	TIL321/2	130p
DL 747 Gr	225p	TIL330	140p
FND357	120p	7750/60	200p
FND500	90p	BARGRAPH	225p
FND507	90p	DRIVERS	
MAN3640	200p	9368	250p
MAN4640	200p	9370	300p
MAN6610	200p	UDN6118	320p
		UDN6184	320p

★ SPÉCIAL OFFER ★

2114L	80p	4116−2	80p
2716 (+5V)	250p	4164−2	450p
2532	350p	6116P−3	350p

TRANSISTORS

BC107/8	14p	BC548C	9p	MJ2955	90p	2N2219A	25p
BC108/9	15p	BC549C	12p	MJ3001	225p	2N2222A	25p
BC109/C	16p	BC557B	12p	MJE2955	130p	2N2484	25p
BC140	30p	BC558B	12p	MJE3055	70p	2N2646	45p
BC141	30p	BC559C	16p	MPF102	30p	2N2905A	25p
BC160	30p	BCY71/2	20p	MPF103/4	30p	2N3053	25p
BC161	30p	BD131	60p	MPF105	30p	2N3054	55p
BC177	16p	BD132	40p	MPSA12	30p	2N3055	35p
BC179C	18p	BD135	40p	TIP29C	40p	2N3442	140p
BC182/L	10p	BD136	35p	TIP31B	40p	2N3702/3	10p
BC183/L	10p	BD139	40p	TIP31C	50p	2N3704/5	10p
BC184/L	10p	BD241B	75p	TIP32A/C	75p	2N3773	200p
BC212/L	12p	BD242B	75p	TIP32C	50p	2N3819	20p
BC213/L	11p	BF244B	25p	TIP33C	70p	2N3820	40p
BC214/L	10p	BF256B	45p	TIP35C	150p	2N3866	90p
BC327	10p	BF257/8	30p	TIP36C	160p	2N3904/6	15p
BC337	10p	BF259	35p	TIP41C	55p	2N4871	50p
BC338	15p	BF337	30p	TIP42A	50p	2N5245	40p
BC477	30p	BFR80/81	25p	TIP42C	60p	2N5457/8	30p
BC516/7	36p	BFY50/51	24p	TIP47	90p	2N5459	30p
BC547B	12p	BFY52	24p	TIP54	160p	2N6027	30p
		BFY90	75p	TIP2955	60p	3N128	120p
		MJ2501	225p	TIP3055	60p	3N140/1	120p
				2N2160	295p	40673	75p
						40871/2	100p

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IN5404/7	19p
IS920	9p

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1A100V	20p
1A600V	30p
2A50V	30p
2A100V	35p
2A400V	45p
3A200V	60p
4A100V	95p
4A400V	100p
6A50V	80p
6A100V	100p
6A400V	120p
8A100V	150p
10A100V	180p
10A400V	200p

SCRS

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16A100V	200p
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2N4444	140p
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T1206D	50p
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4116L-20	80p

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elektor infocard 78 | Microcomputer ICs 5 | Static RAMs

Static RAMs (RAM = **R**andom **A**ccess **M**emory) are intended for storing digital data in computer systems. A single memory cell (for one data bit) is similar to a flip-flop: it can be set, cleared and 'read'. Static RAMs are currently available in NMOS, HMOS and CMOS technology. In the quiescent state, the current consumption of CMOS RAMs is in the order of micro-amps, making them especially suitable for battery back-up applications. In general, these ICs are easy to use, require relatively little power and provide fast access. The memory organisation can be 1 bit, 4 bit or even 8 bit wide; a byte-wide memory using 1 bit types will obviously require 8 ICs 'in parallel'.

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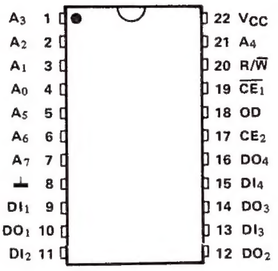
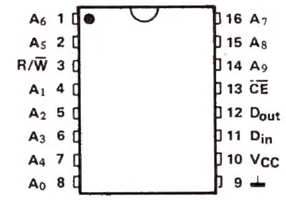
elektor infocard 79 | Microcomputer ICs 6 | Static RAMs Pinning

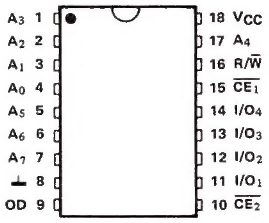
2101



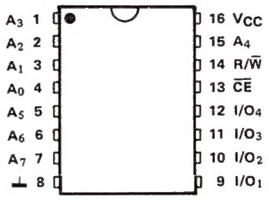
2102



2111



2112



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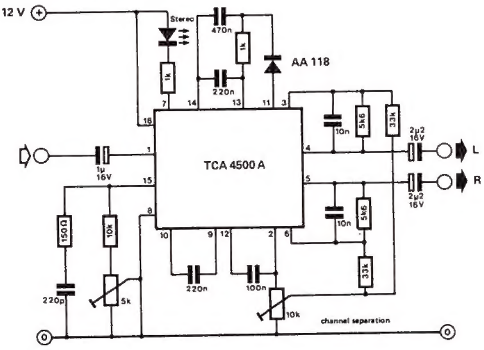
elektor infocard 80 | Applications 9 | FM stereo decoders

If a stereo decoder is to be added to a VHF-FM receiver, the de-emphasis network must be removed from the demodulator. In the circuits given in infocard 56, for instance, this means that the 6n8, 10 n or 22 n capacitors at the AF output must be deleted.

TCA 4500A

Supply voltage range:	8 V . . . 16 V
Preferred supply voltage:	12 V
Current consumption (without LED):	typ. 35 mA
THD max. (900 mV_{RMS}):	0.3%
THD typ. (500 mV_{RMS}):	0.2%
Overall gain:	typ. 0 dB
SNR:	typ. 85 dB
Minimum channel separation, after calibration:	40 dB
without calibration:	30 dB

Automatic stereo width adjustment included



elektor infocard 78

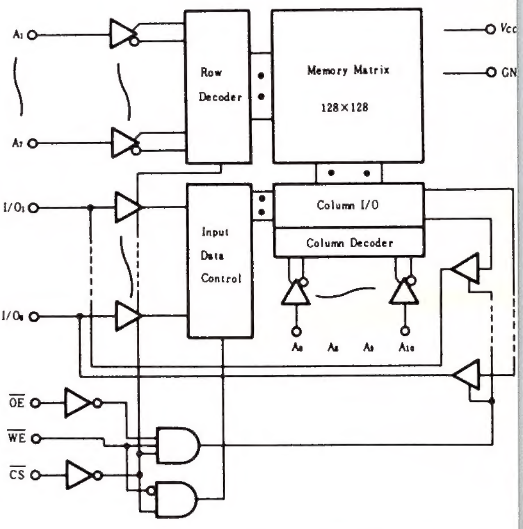
Microcomputer ICs 5

Static RAMs
Memory organisation and pin assignments

Type	Memory organisation	Technology
2101	256 x 4 bit	NMOS
2102	1024 x 1 bit	NMOS
2111	256 x 4 bit	NMOS
2112	1024 x 1 bit	NMOS
2114(A)	1024 x 4 bit	NMOS (HMOS)
5116	2048 x 8 bit	CMOS
5117	2048 x 8 bit	CMOS
6116	2048 x 8 bit	CMOS
6117	2048 x 8 bit	CMOS
6167	16384 x 1 bit	CMOS
5188	8192 x 8 bit	CMOS
5564	8192 x 8 bit	CMOS
5565	8192 x 8 bit	CMOS

Pin assignments

V_{CC} = +5 V
CS = Chip Select
CE = Chip Enable
WE = Write Enable
OE = Output Enable
$A_0 \ldots A_{12}$ = Address inputs
$I/O_1 \ldots I/O_8$, D_{in}, D_{out}, $DI_1 \ldots DI_4$, $DO_1 \ldots DO_4$ = Data in- and outputs
NC = not connected



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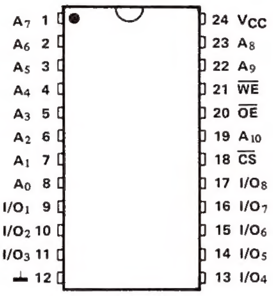
elektor infocard 79

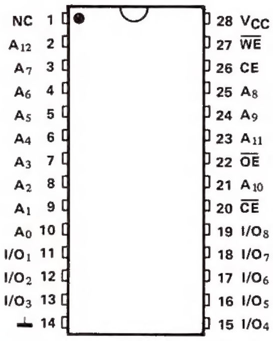
Microcomputer ICs 6

Static RAMs
Pinning

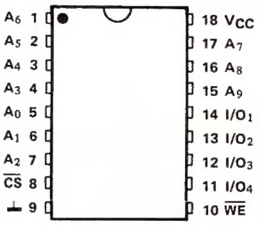
5116
5117
6116
6117



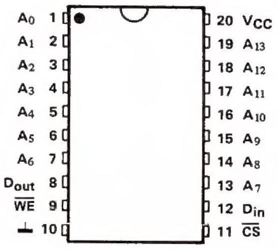
5188
5564
5565



2114



6167



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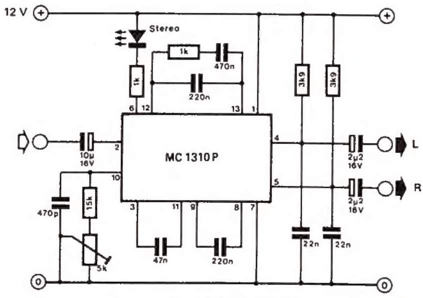
elektor infocard 80

Applications 9

FM stereo decoders

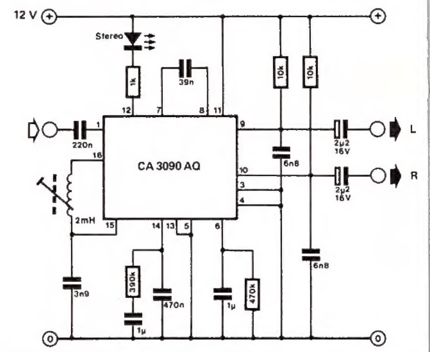
MC1310P

Supply voltage range: 8 V . . . 14 V
Preferred supply voltage: 12 V
Current consumption (without LED): typ. 13 mA
Max. input voltage: 1 V_{RMS}
Output voltage: typ. 485 mV_{RMS}
THD: typ. 0.3%
Channel separation: typ. 40 dB



CA3090AQ

Supply voltage range: 10 V . . . 16 V
Preferred supply voltage: 12 V
Current consumption (without LED): typ. 22 mA
Input voltage range: 180 . . . 240 mV_{RMS}
Overall gain (mono): typ. 6 dB
THD: typ. 0.22%
Channel separation: typ. 40 dB



contents

selektor 4-20

low-power digital thermometer 4-22
E. Schmidt
The thermometer described in this article can be operated continuously for more than six months without changing the battery. That is quite an achievement and already makes our last thermometer circuit appear a little obsolete!

MC/MM phono preamp 4-26
The phono preamp is an important part of the Prelude, or indeed of any audio system. Most really good cartridges are the moving coil type, and these require a step-up transformer or, as is more common nowadays, a so-called pre-preamp. The phono preamp and the moving coil pre-preamp described in this article are designed to form a single module. This can be incorporated in any audio system, although it is intended as part of the Prelude.

technical answers 4-33
National filter with application fault; marking of digitast switches; slave flashgun powered by the mains; Crescendo coils and S/N ratio.

membrane switches 4-34
The membrane switch — or foil switch as it is becoming popularly known — is almost too good to be true. The switch is both reliable and inexpensive. These two factors coupled with its 'science fiction' appearance can provide the basis for a very elegant and economical keyboard that the more conventional switch cannot hope to match.

interlude 4-36
The convenience of remote-control for television sets is fairly well-known. The Interlude brings the same armchair operation to the world of hi-fi audio: volume, balance, tone, even input select — all controlled from the 'ideal listening position'.

RC equalizer 4-40

7-day timer/controller 4-42
The last time we published a single-chip programmable timer was way back in May 1979 and the circuit became very popular (and still is). However, the IC used at the time is now a little 'thin on the ground' and it's about time the subject was brought up to date. The circuit here uses the TMS 1601 from Texas Instruments, a single-chip microcomputer specifically designed for this purpose.

junior program tester 4-51
P. Wild

Prelude (Part 3) 4-52
The end is in sight! We have now reached the final constructional article in the Prelude series: the printed circuit board for the tone control.

programmable darkroom timer 4-56
Many amateur photographers will be interested in this circuit: a programmable timer for seven preselectable times. The time can be adjusted in two ranges (up to 99.9 s and up to 999 s). Fourteen keys are used for programming. When the start key is pressed, the time countdown can be observed on the display.

talking-clock extension 4-60
E.A.J. Bogers

market 4-61

switchboard 4-65

EPS service 4-80

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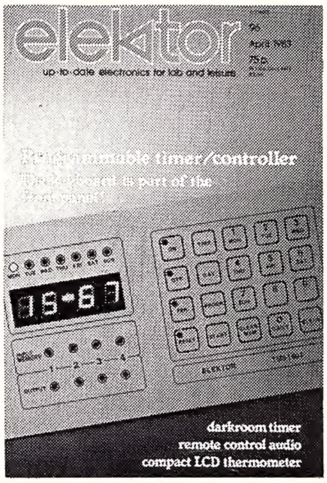

The front panel for the 7-day timer/controller includes a membrane-switch keypad and red trans lucent windows for the LEDs and display. Anyone who happens to notice something out of the ordinary in the time display is referred to the top right-hand corner of this month's cover.

elektor decoder

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What is 10 n?
What is the EPS service?
What is the TQ service?
What is a missing link?

Semiconductor types
Very often, a large number of equivalent semiconductors exist with different type numbers. For this reason, 'abbreviated' type numbers are used in Elektor wherever possible:

- '741' stand for μA 741, LM 741, MC 1741, MIC 741, RM 741, SN 72741, etc.
- 'BC 107B', 'BC 237B', 'BC 547B' all refer to the same 'family' of almost identical better-quality silicon transistors. In general, any other member of the same family can be used instead.

BC 107 (-8, -9) families:
BC 107 (-8, -9), BC 147 (-8, -9), BC 207 (-8, -9), BC 237 (-8, -9), BC 317 (-8, -9), BC 347 (-8, -9), BC 547 (-8, -9), BC 171 (-2, -3), BC 182 (-3, -4), BC 382 (-3, -4), BC 437 (-8, -9), BC 414

BC 177 (-8, -9) families:
BC 177 (-8, -9), BC 157 (-8, -9), BC 204 (-5, -6), BC 307 (-8, -9), BC 320 (-1, -2), BC 350 (-1, -2), BC 557 (-8, -9), BC 251 (-2, -3), BC 212 (-3, -4), BC 512 (-3, -4), BC 261 (-2, -3), BC 416.

Resistors and capacitor values
When giving component values, decimal points and large numbers of zeros are avoided wherever possible. The decimal points is usually replaced by one of the following abbreviations:

p (pico-) = 10^{-12}
n (nano-) = 10^{-9}
μ (micro-) = 10^{-6}
m (milli-) = 10^{-3}
k (kilo-) = 10^{3}
M (mega-) = 10^{6}
G (giga-) = 10^{9}

A few examples:
Resistance value 2k7: 2700 Ω.
Resistance value 470: 470 Ω.
Capacitance value 4p7: 4,7 pF or 0,000 000 000 004 7 F . . .
Capacitance value 10 n: this is the international way of writing 10,000 pF or .01 μF, since 1 n is 10^{-9} farads or 1000 pF;
Resistors are ¼ Watt 5% carbon types, unless otherwise specified. The DC working voltage of capacitors (other than electrolytics) is normally assumed to be at least 60 V. As a rule of thumb, a safe value is usually approximately twice the DC-supply voltage.

Test voltages
The DC test voltages shown are mesured with a 20 kΩ/V instrument, unless otherwise specified.

U, not V
The international letter symbol 'U' for voltage is often used instead of the ambiguous 'V'. 'V' is normally reserved for 'volts'. For instance: $U_b = 10$ V, not $V_b = 10$ V.

Mains voltages
No mains (power line) voltages are listed in Elektor circuits. It is assumed that our readers know what voltage is standard in their part of the world!
Readers in countries that use 60 Hz should note that Elektor circuits are designed for 50 Hz operation. This will not normally be a problem; however, in cases where the mains frequency is used for synchronisation some modification may be required.

Technical services to readers

- **EPS service.** Many Elektor articles include a lay-out for a printed circuit board. Some — but not all — of these boards are available ready-etched and predrilled. The 'EPS print service' in the current issue always gives a complete list of available boards.
- **Technical queries.** Members of the technical staff are available to answer technical queries (relating to articles published in Elektor) by telephone on Monday's from 13.30 to 16.15. Letters with technical queries should be addressed to: Dept. TQ. Please enclose a stamped, self addressed envelope; readers outside U.K. please enclose an IRC instead of stamps.
- **Missing link.** Any important modifications to, additions to, improvements to or corrections in Elektor circuits are generally listed under the heading 'Missing Link' at the earliest opportunity.

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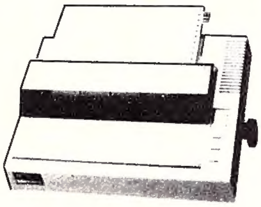

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47, 68, 100 **9p**; 125 **12p**; 330 **16p**; 470 **20p**; 680 **34p**; 1000 **27p**; 1500 **31p**; 2200 **36p**; 4700 **79p**.

TAG-END CAPACITORS: **64V**: 2200 **139p**; 3300 **198p**; 4700 **245p**; **50V**: 2200 **110p**; 3300 **164p**; **40V**: 4700 **180p**; **25V**: 2200 **90p**; 3300 **98p**; 4000, 4700 **98p**; 10,000 **320p**; 15,000 **345p**; **16V**: 22,000 **360p**

POLYESTER CAPACITORS: Axial Lead Type
400V: 1nF, 1n5, 2n2, 3n3, 4n7, 6n8 **11p**; 10n, 15n, 18n, 22n **12p**; 33n, 47n, 68n **16p**; 150n **20p**; 220n **30p**; 330n **42p**; 470n **52p**; 680n 1uF **68p**; 2u2 **82p**.
160V: 10nF, 12n, 39n, 100n **11p**; 150n, 220n **17p**; 330n, 470n **30p**; 680n **38p**; 1uF **42p**; 1u5 **46p**; 2u2 **48p**; 4u7 **58p**.
1000V: 1nF **17p**; 10nF **30p**; 15n **40p**; 22n **36p**; 33n **42p**; 47n, 100n **42p**.

SIEMENS pcb Type Miniature poly Capacitors

250V
1nF, 1n5, 2n2, 3n3, 4n7, 6n8, 10n, 15n **7p**
18n, 22n, 27n, 33n, 39n, 47n **8p**
39n, 56n **12p**
82n, 100n **11p**

100V
100n, 120n **10p**
150n, 180n **12p**
220n, 270n **15p**
330n, 390n **20p**
470n, 560n **26p**
680r **30p**
1uF **34p** 2u2 **50p**

POLYESTER RADIAL LEAD CAPACITORS: 250V
10n, 15n, 22n, 27n **6p**; 33n, 47n, 68n, 100n **7p**; 150n, 220n **10p**; 330n, 470n **13p**; 680n **19p**; 1u **23p**; 1u5 **40p**; 2u2 **46p**.

FEED-THROUGH CAPACITORS
1000pF/450V **8p**

TANTALUM BEAD CAPACITORS
35V: 0.1uF, 0-22, 0-33 **15p**; 0-47, 0-68, 1-0, 1.5 **16p**; 2.2, 3-3 **18p**; 4.7, 6.8 **22p**; 10 **28p**; **16V**: 2.2, 3.3 **16p**; 4.7, 6.8, 10 **18p**; 15, **36p**; 22 **30p**; 33, 47 **40p**; 100 **75p**; **10V**: 15, 22, **26p**; 33, 47 **35p**; 100 **55p**; **6V**: 100 **42p**.

POTENTIOMETERS: Rotary, Carbon, Track 0.25W Log & Lin values.
500Ω, 1KΩ & 2KΩ (Linear only) Single Gang. **30p**
5KΩ-2MΩ Single Gang Log & Lin **30p**
5KΩ-2MΩ Single Gang D/P Switch **78p**
5KΩ-2MΩ Double Gang **89p**

MYLAR FILM CAPACITORS
100V: 1nF, 2, 4, 4nF, 10 **6p**; 15nF, 22n, 30n, 40n, 47n **7p**; 56n, 100n, 200n **9p**; **50V**: 470nF **12p**.

SLIDER POTENTIOMETERS
0-25W log and linear values 60mm
5KΩ-500KΩ single gang **70p**
10KΩ-500KΩ dual gang **110p**
Self Stick Graduated Bezel **40p**

CERAMIC CAPACITORS 50V:
Range: 0-5pF to 10nF **4p**. 15nF; 22nF; 33nF; 47nF **5p**. 100nF/30V **7p**. 200nF/6V **8p**.

PRESET POTENTIOMETERS
0.1W 50Ω 5MΩ Miniature
Vertical & Horizontal **7p**
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10pF to 1nF **8p**; 1.5nF to 12nF **10p**

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2, 3-3, 4.7, 6.8, 8.2, 10, 12, 15, 18, 22, 27, 33, 39, 47, 50, 56, 68, 75, 82, 85, 100, 120, 150, 180pF **15p each**
200, 220, 250, 270, 300, 330, 360, 390, 470, 800, 800, 820 **21p each**
1000, 1200, 1800, 2200 **30p each**
3300, 4700pF **60p each**

MINIATURE TRIMMERS Capacitors
2-6pF, 2-10pF **22p**; 2-25pF, 5-60pF **30p**; 10-88pF **36p**.

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½ W	2Ω2-4M7	E12	2p	1p
1 W	2Ω2-4M7	E12	6p	4p
2% Metal Film		E24	6p	4p
1% Metal Film		E24	8p	6p

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RESISTORS Network S.I.L.
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2764	590
3242	590
4027	190
4116-150n	85
4116-200n	80
4118-250	325
4164-200n	425
4334-3	CMOS
4532-3	350
4532-4	350
4816-100n	215
5101-450	220
6116-150n	375
6116L 120	550
6117-110n	490
6502 CPU	325
6503	600
6504 250	550
6505	600
6520 PIA	100
6522 VIA	295
6530	£11
6352	570
6545 RTC	899
6551 ACIA	650
6592 PC	£20
6800	220
6802	250
6803	850
6804	160
6805	670
6808	520
6809	630
6810	115
6820	110
6821	110
68B21	220
6840	375
6843	£12
6845	650
6847	650
6850	110
6852	250
6854	599
68B54	780
6875	500
68000	£78
74C922	420
8080 A	250
8085 A	350
8088	£18
8118-10	225
8123	125
8155	350
8156	350
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81LS96	80
81LS97	80
81LS98	85
8202	£25
8205	225
8212	110
8214	425
8216	100
8224	110
8225	£11
8226	250
8228	220
8243	270

8250	850
8251 A	250
8253	400
8255	225
8256 AC	£36
8257-5	400
8259	395
8271	£32
8279	385
8283	00
8284	350
8287	00
8288	£10
8P8304BN	250
8T26A	99
8T27	150
8T28A	120
8T31	350
8T95	90
8T97N	90
9364AP	550
9602	220
AM26LS31C	125
AM26LS32A	125
AM26LS33A	125
AY-3-1015	300
AY-5-1350	388
AY-5-2376	600
COM8017	275
COM8116	700
DM8131	275
DS3691N	320
DS88LS120N	275
DS8820	110
DS8830	110
DS8831	125
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MC1489	55
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Z80 PIO	260
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Z80 SIO-1	850
Z80A SIO	£9

LINEAR ICs

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702	75
709C 8 pin	35
710	48
741-8 pin	14
747C 14pin	65
748C 8 pin	36
753 8 pin	185
810	159
9400CJ	350
AD7581	£11
AY-1-1320	225
AY-1-5050	99
AY-1-5051	160
AY-1-6720	210
AY-3-1270	730
AY-3-1350	350
AY-3-8910	438
Booklet for AY-3-8910	150
AY-3-8912	450
AY-5-1230	450
AY-5-1317A	630
AY-5-1350	388
CA3011	130
CA3012	175
CA3014	275
CA3018	86
CA3019	80
CA3020	210
CA3023	210
CA3028A	95
CA3035	255
CA3036	270
CA3043	275
CA3045	385
CA3046	70
CA3048	220
CA3059	285
CA3075	213
CA3080E	70
CA3081	190
CA3086	48
CA3089E	215
CA3090AQ	375
CA3123E	165
CA3130	90
CA3140	40
CA3160	95
CA3161	160
CA3162E	450
CA3189	200
HA1336W	240
HA1388	255
ICL7106	690
ICL7107	975
ICL7611	99
ICL7660	248
ICL8038CC	300
ICL8211A	150
ICM7205A	1150
ICM7207	475
ICM7215	1050
ICM7216AJ	£22
ICM7216B	£22

ULN2003	75
ICM7216C	£22
ICM7217A	750
ICM7224	785
ICM7240	300
ICM7555	80
ICM7556	150
LA3350	250
LA4031P	340
LA4032	295
LA4400	350
LA4422	320
LC7130	340
LC7120	300
LC7137	395
LF347	150
LF351	48
LF353	95
LF355	85
LF356	95
LF357	110
LF398	475
LM10	325
LM301AO	24
LM307	45
LM308T	95
LM311	70
LM318N	150
LM319	215
LM324A	30
LM334Z	90
LM335Z	128
LM339	47
LM348	64
LM349	115
LM358	60
LM377	175
LM379	480
LM380	75
LM381N	145
LM382	115
LM384	160
LM386	90
LM387	120
LM389	95
LM392	60
LM393	100
LM558	75
LM725CN	325
LM733	70
LM1458	45
LM1871	325
LM2917	195
LM3302	75
LM3900	50
LM3909N	85
LM3911	125
LM3914	250
LM3915	250
LM3916	250
LM13600	110
LS7220	280
M253AA	1150
M51513L	230
M51515L	320
M51516L	475
MB3712	220
MB3756	440
MC1204	250
MC1301	79
MC1303	98
MC1304P	260
MC1310P	150
MC1445	250
MC145106	695
MC1469	300
MC1494	694
MC1495	350
MC1496L	70
MC1596	225
MC1648	290
MC1709G	90
MC3302	90
MC3340P	120
MC3360P	120

MC3401	65
MC3403	75
MC3405	150
MC3423	180
MC4016	00
MF10	350
MFC6040	75
MK50398	635
ML924	275
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NE515	275
NE529	225
NE531	140
NE534	150
NE543K	225
NE544	210
NE555	16
NE556	45
NE560	325
NE561	398
NE562B	410
NE564	420
NE565A	120
NE566	155
NE567V	140
NE570	410
NE571	400
NE5532	145
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OM335	750
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RC4558	45
S566B	225
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SN76013	350
SN76023ND	240
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SN76227N	95
SN76477	420
SN76488	480
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SP8629	299
TA7120	125
TA7130	150
TA7204	175
TA7205	90
TA7222	150
TA7310	160
TAA621AX1	295
TAA661A	190
TAA700	275
TAA900	395
TAD100	159
TBA120S	70
TBA540Q	275
TBA550Q	330
TBA641BX or BX11	290
TBA651	190
TBA800	80
TBA810	95
TBA820	80
TBA920Q	200
TBA950	300
TBA990Q	350
TBA540	275
TC9109	775
TCA220	350
TCA270Q	350
TCA280A	220
TCA940	175
TCA965	145
TDA1004	290
TDA1008	310
TDA1022	499
TDA1024	115
TDA1034	350
TDA1490	350
TDA2002	325

TDA2003	198
TDA2004	495
TDA2006	330
TDA2020	320
TDA2030	295
TDB0701	420
TL170	50
TL430	65
TL061CP	40
TL062CP	60
TLO64CN	98
TLO71CP	24
TLO72CP	45
TLO74CN	100
TLO81CP	24
TLO82CP	45
TLO83CP	75
TLO84CN	90
TLO91CP	55
UA2240	120
UA78540	230
UAA170	170
UAA180	180
ULN2003	75
ULN2004	75
ULN2283	100
UPC575	275
UPC1025H	375
UPC1182	330
UPC1156H	275
UPC1366	195
XR2206	300
XR2207	375
XR2211	575
XR2216	675
XR2266	360
ZN414	80
ZN419E	180
ZN423E	130
ZN424E	130
ZN425E	345
ZN426E	300
ZN427E	600
ZN428E	410
ZN429E	210
ZN459	570
ZN1034E	200
ZN1040E	665
ZNA234E	850

DIODES

AA119	15
AA129	20
AAY30	15
BA100	15
BAX13	20
BY100	24
BY126	12
BY127	12
CRO33	250
OA9	40
OA47	12
OA70	12
OA79	15
OA81	20
OA85	15
OA90	8
OA91	8
OA95	8
OA200	8
OA202	8
1N914	4
1N916	5
1N4001/2	5
1N4003	6
1N4004/5	6
1N4006/7	7
1N4148	4
1N5401	15
1N5404	16
1N5406	17
1N5408	19
1S44	9
1S921	9
6A/100V	40
6A/400V	50
6A/800V	65

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1A/50V	18
1A/100V	20
1A/400V	25
1A/600V	34
2A/50V	30
2A/200V	40
2A/400V	46
2A/600V	65
6A/100V	83
6A/400V	95
6A/600V	125
10A/200V	215
10A/600V	298
25A/200V	240
25A/600V	395
BY164	56
VM18 DIL	50

75 SERIES

75107/8	95
75110	90
75114/5	150
75121/2	130
75150	125
75154	125
75182/3	99
75188/9	55
75322	140
75324	360
75361/3	150
75365	150
75450	86
75451/2	52
75454	70
75491/2	65

ZENERS
Range: 2V7 to 39V 400mW **8p each**
Range: 3V3 to 33V. 1.3W **15p each**

SCR THYRISTORS

5A/40V	32
5A 400V	40
5A 600V	48
8A 300V	60
8A 600V	90
12A 100V	78
12A 400V	96
12A 800V	188
BT106	150
BT116	180
C106D	38
TIC44	24
TIC45	29
TIC47	35
2N5062	32
2N5064	38
2N4444	130

TRIACS

3A 200V	54
3A 400V	56
8A 100V	60
8A 400V	69
8A 800V	115
12A 100V	78
12A 400V	82
12A 800V	136
16A 100V	103
16A 400V	106
16A 800V	220
25V 500V	220
25A 800V	296
T2800D	120

NOISE Diode
Z5J **196p**

VARICAPS

BA102	50
BB105B	40
BB106	40
BB109B	45
MVAM2	165

DIAC
ST2 **25**

TRANSISTORS

AC126/7	36
AC141/2	30
AC176	28
AC187	32
AC188	32
ACY19/21	75
ACY22/41	75
AD142	120
AD149	79
AD161	42
AD162	42
AF115/6	60
AF118	80
AF124/26	70
AF139	40
AF178	75
AF186	70
AF239	55
BC107	10
BC107B	12
BC108	10
BC108B	12
BC109	10
BC109B	12
BC109C	12
BC114/5	22
BC117/8	20
BC137/9	40
BC140	30
BC142/3	30
BC147	9
BC147B	10
BC148	9
BC148B	10
BC149	9
BC149C	10
BC153/4	27
BC157/8	10
BC159	11
BC160	46
BC167A	10
BC168C	10
BC169C	10
BC170	15
BC171/2	11
BC173	11
BC177/8	16
BC179	20
BC181	20
BC182/3	10
BC184	10
BC182L	10
BC183L	10
BC184L	10
BC186/7	28
BC212	10
BC212L	10
BC213	10

BC213L	10
BC214	10
BC214L	10
BC237/8	14
BC307B	14
BC308	16
BC256B	30
BC318	30
BC327/8	15
BC337/8	15
BC441/61	34
BC477	40
BC516/7	40
BC547/8	12
BC549C	14
BC556/7	15
BC558/9	15
BCY30	68
BCY34	85
BCY41/42	14
BCY45	50
BCY58/59	36
BCY70/71	16
BCY72	20
BCY78	24
BD112	125
BD121	96
BD124	115
BD131/32	48
BD133	70
BD135	46
BD136/37	40
BD138/39	40
BD140	40
BD144	190
BD158	55
BD205/6	110
BD222	85
BD245	45
BD378	70
BD434	55
BD517	75
BD645	80
BD695A	125
BD696A	125
BDY56	180
BDY60	180
BF115	36
BF154/8	25
BF167	29
BF173	27
BF177	25
BF178	30
BF179	36
BF184/5	38
BF194/5	12
BF196/7	12
BF198/9	18

BF200	80
BF224A	25
BF224B	29
BF245	30
BF256A	36
BF256B	46
BF257/8	32
BF259	35
BF274	42
BF336/7	40
BF394	27
BF451	36
BF494/5	30
BF594/5	30
BFR39/40	23
BFR41/79	23
BFR80/81	25
BFR98	106
BFX29	28
BFX81	45
BFX84	28
BFX85/6	28
BFY18	50
BFY50/51	23
BFY52	23
BFY53	32
BFY55/6	32
BFY64	35
BFY81	120
BFY90	80
BRY39	40
BSX20	20
BSX26/29	34
BSX78	46
BSY26	30
BSY95A	26
BU105	170
BU205	190
BU206	200
BU208	200
BUY69C	225
E421	250
MD8001	250
MJ491	175
MJ2955	70
MJE170	150
MJE180	150
MJE340	54
MJE370	100
MJE371	100
MJE520	96
MJE521	96
MJE2955	99
MJE3055	70
MPF102	40
MPF103	30
MPF104	30
MPF105	30

MPF106	40
MPSA05	25
MPSA08	25
MPSA12	32
MPSA55	30
MPSA56	30
MPSA70	30
MPSU02	58
MPSU05	56
MPSU06	56
MPSU52	65
MPSU55	50
MPSU56	60
MPSU56	60
MPU131	52
OC26	170
OC28/35	220
OC36/41	75
OC42	50
OC70	40
OC71/72	40
OC75/76	40
OC81/82	50
OC83/84	40
OC170/71	50
OC200	50
TIP29A	32
TIP29C	38
TIP30A	35
TIP30C	37
TIP31A	38
TIP31B	39
TIP31C	39
TIP32A	36
TIP32C	42
TIP33A	65
TIP33C	78
TIP34A	74
TIP34C	88
TIP35A	110
TIP35C	128
TIP36A	130
TIP36C	140
TIP41A	50
TIP41B	52
TIP42A	55
TIP42B	58
TIP120	70
TIP121/2	73
TIP141/2	106
TIP147	120
TIP2955	60
TIP3055	60
TIS43	32
TIS44/5	45
TIS46	45
TIS48	50
TIS59/74	50
TIS88A	50
TIS90/91	30
UC734	65

VK101	80
VN10KM	55
VN46AF	78
VN66AF	80
VN88AF	94
VN89AF	96
ZTX107/8	11
ZTX109	12
ZTX212	28
ZTX300	13
ZTX301	16
ZTX302	16
ZTX303	25
ZTX304	17
ZTX314	25
ZTX326	30
ZTX341	30
ZTX451	23
ZTX500	14
ZTX501/2	15
ZTX503	18
ZTX504	25
ZTX531	25
ZTX550	25
2N697	23
2N698	40
2N699	48
2N706A	19
2N708	19
2N918	35
2N1131/2	24
2N1302	46
2N1671B	160
2N160	295
2N2217	46
2N2218A	25
2N2219A	28
2N2220A	26
2N2221A	26
2N2222A	26
2N2303	46
2N2368	25
2N2369A	18
2N2476	50
2N2483/4	27
2N2646	46
2N2904/5	26
2N2906/7	26
2N2907A	26
2N2926G	10
2N3011	26
2N3053	26
2N3054	58
2N3055	48
2N3252	46
2N3302	30
2N3441/2	140
2N3614/5	199
2N3663	15
2N3702/3	10
2N3704/5	10

2N3706/7	10
2N3708/9	10
2N3710/11	10
2N3713	140
2N3771	179
2N3772	196
2N3773	210
2N3819	22
2N3820	36
2N3822/3	45
2N3824	66
2N3866	90
2N3903/4	15
2N3905/6	15
2N3906	17
2N4037	46
2N4058	10
2N4061/2	10
2N4064	115
2N4234	48
2N4264	24
2N4286	15
2N4289	18
2N4314	78
2N4400	18
2N4427	80
2N4871	55
2N4898	135
2N4901	175
2N4921	55
2N4922	70
2N5135/6	20
2N5138	18
2N5172	18
2N5179	45
2N5180	45
2N5190/1	75
2N5194	80
2N5305/8	30
2N5457/8	30
2N5459	30
2N5485	36
2N5777	46
2N5879	190
2N6027	32
2SA671	250
2SA715	60
2SC495	70
2SC496	70
2SC1061	250
2SC1096	85
2SC1162	30
2SC1173	125
2SC1306	100
2SC1307	150
2SC1449	85
2SC1678	140
2SC1679	190
2SC1923	50
2SC1945	225
2SC1963	90

2SC1957	9
2SC1969	14
2SC2028	8
2SC2029	21
2SC2078	17
2SC2091	8
2SC2314	8
2SC2166	19
2SC2335	22
2SC2547	3
2SC2612	22
2SD234	7
2SK45	9
2SK288	22
2SJ83	22
2SJ85	22
3N128	11
3N140	11
40315	9
40316	9
40324	10
40326/7	7
40347	9
40348	12
40360	8
40361/2	
40407/8	
40411	28
40412	9
40467A	13
40468	8
40594	10
40603	1
40673	
40871/2	9

RF CHOKES Miniature PCB typ
1uH, 2u
4u7, 10u, 22
33u, 47
100u, 220
330u, 470
3
1mH, 1m
2m2, 4m
10mH 3
22m, 33m
43m 6
100m 7

TTL74

7400	11
7401	11
7402	11
7403	12
7404	13
7405	15
7406	20
7407	20
7408	14
7409	14
7410	14
7411	16
7412	18
7413	18
7414	24
7416	20
7417	20
7420	15
7421	20
7422	20
7423	20
7425	18
7426	18
7427	15
7428	26
7430	14
7432	22

7433	22
7437	25
7438	22
7440	15
7441	55
7442	32
7443	90
7444	90
7445	55
7446	60
7447	40
7448	45
7450	16
7451	16
7453	16
7454	16
7460	16
7470	35
7472	24
7473	26
7474	20
7475	25
7476	25
7480	48
7481	120
7482	65
7483	38
7484	70
7485	60
7486	20
7489	170
7490	20
7491	35
7492	25
7493	25
7494	35
7495	35
7496	35
7497	90
74100	80
74104	50
74105	55
74107	20
74109	25
74110	35
74111	55
74112	170
74116	50
74118	55
74119	60
74120	60
74121	25
74122	35
74123	35
74125	35
74126	35
74128	35
74132	30
74136	28
74141	55
74142	175
74143	210
74144	210
74145	50
74147	75
74148	60
74150	50
74151	40
74153	40
74154	55
74155	40
74156	40
74157	30
74159	80
74160	80
74161	48
74162	40
74163	40
74164	40
74165	48
74166	48
74167	150

74170	125
74172	250
74173	60
74174	54
74175	55
74176	40
74177	45
74178	80
74179	80
74180	40
74181	115
74182	60
74184	90
74185	95
74188	250
74190	48
74191	46
74192	46
74193	45
74194	40
74195	40
74196	46
74197	40
74198	80
74199	84
74221	54
74246	120
74247	120
74248	120
74249	120
74251	65
74259	150
74265	55
74273	150
74276	120
74278	100
74279	50
74283	50
74284	155
74285	155
74290	105
74293	80
74297	236
74298	100
74351	195
74365	30
74366	30
74367	30
74368	30
74390	75
74393	90
74490	95

74C

74C244	195
74C245	195
74C373	240
74C374	245
74C922	420
74C923	500

74S

74S00	30
S02	30
S03	30
S04	30
S05	60
S08	60
S20	40
S32	70
S74	75
S86	65
S112	80

S114	80
S132	110
S133	60
S138	100
S139	115
S157	225
S158	210
S188	140
S189	140
S194	195
S195	195
S201	250
S225	240
S241	250
S244	290
S251	170
S257	170
S262	850
S287	225
S288	210
S289	200
S301	350
S412	380
S470	325
S471	620
S472	1150
S475	800
S571	620

74LS

LS00	11
LS01	11
LS02	11
LS03	12
LS04	12
LS05	12
LS08	12
LS09	12
LS10	12
LS11	12
LS12	13
LS13	15
LS14	26
LS15	12
LS20	12
LS21	12
LS22	12
LS24	75
LS26	12
LS27	13
LS28	14
LS30	13
LS32	13
LS33	15
LS37	15
LS38	15
LS40	13
LS42	28
LS47	35
LS48	45
LS49	50
LS51	14
LS54	14
LS55	14
LS63	120
LS73	18
LS74	18
LS75	20
LS76	18
LS78	18
LS83	36
LS35	42
LS86	16
LS90	24
LS91	60
LS92	32
LS93	23
LS95	40
LS96	95
LS107	40
LS109	23
LS112	22
LS113	20
LS114	22
LS122	36

LS123	
LS124	
LS125	
LS126	
LS132	
LS133	
LS136	
LS138	
LS139	
LS145	
LS147	1
LS148	
LS151	
LS153	
LS155	
LS156	
LS157	
LS158	
LS160	
LS161	
LS162	
LS163	
LS164	
LS165	
LS166	
LS168	
LS170	
LS173	
LS174	
LS175	
LS181	
LS183	1
LS190	
LS191	
LS192	
LS193	
LS194	
LS195	
LS196	
LS197	
LS200	2
LS202	2
LS221	
LS240	
LS241	
LS242	
LS243	
LS244	5
LS245	7
LS247	5
LS248	
LS249	
LS251	
LS253	
LS257	
LS258	
LS259	
LS260	
LS261	1
LS266	
LS273	
LS275	1
LS279	
LS280	
LS283	
LS290	
LS293	
LS295	
LS298	
LS299	1
LS300	1
LS302	1
LS320	2
LS323	1
LS324	1
LS325	2
LS326	2
LS327	2
LS347	
LS348	
LS352	
LS353	

WITCHES

)GGLE: 2A, 250V.	
›ST	33p
›DT	44p

JB-MIN TOGGLE

›ST on/off	54p
›DT c/over	60p
›DT centre off	85p
›DT biased both ays	105p
›DT 6 tags	75p
›DT centre off	88p
›DT biased both ays	145p
›DT 3 positions ı/on/on	185p
pole 2 way	205p

.IDE 250V:

›DT 1A	14p
›DT 1A c/off	15p
›DT ½A	13p

JSHBUTTON 6A
th 10mm Button

›DT latching	99p
›DT latching	145p
›DT moment	99p
›DT moment	145p

ını Non Locking

ısh to Make	15p
ısh to Break	25p

DIL SWITCHES
(SPST) 4 way **70p**; 6 way **85p**; 8 way **90p**; 10 way **145p**. (SPDT) 4 way **190p**.

ROTARY SWITCHES: (Adjustable Stop type)
1 pole/2 to 12 way; 2p/2 to 6 way; 3 pole/2 to 4 way; 4p/2 to 3 way **45p**

ROTARY: Mains DP 250V 4 Amp on/off **68p**

ROTARY: (Mak-a-switch)
Make a multiway switch. Shafting assembly has adjustable stop. Accommodates up to 6 wafers (max. 6 pole/12 way + DP switch). Mechanism only **90p**

WAFERS: (make before break) to fit the above switch mechanism.
1 pole/12 way; 2 pole/6 way; 3 pole/4 way; 4 pole/3 way; 6-/2 way **65p**
Mains DP 4A Switch to fit **45p**
Spacers **4p**. Screen **6p**

ROCKER: 5A/250V SPST	28p
ROCKER: 10A/250V SPDT	38p
ROCKER: 10A/250V DPDT c/off	95p
ROCKER: 10A/250V DPST with neon	85p

THUMBWHEEL Mini front mounting

Decade Switch Module	**220p**
B.C.D. Switch Module	**275p**
Mounting Cheeks (per pair)	**75p**

LEKTOR
ROJECTS
Ve stock
most of
he parts

JUMPER LEADS (Ribbon Cable Assembly)

Length	14 pin	16 pin	24 pin	40 pin
Single ended DIP (Header Plug) Jumper				
24 inches	145p	165p	240p	380p
Double ended DIP (Header Plug) Jumper				
6 inches	185p	205p	300p	465p
12 inches	198p	215p	315p	490p
24 inches	210p	235p	345p	540p
36 inches	230p	250p	375p	595p

IDC Female Header Socket Jumper Leads 24"

	20 pin	26 pin	34 pin	40 pin
Single ended	180p	200p	280p	300 p
Double ended	290p	370p	480p	525p

VEROBOARD 0.1in	clad	plain
2½ × 3¼	85p	—
2½ × 5"	100p	—
3¾ × 3¾	100p	—
3¾ × 5"	115p	—
3¾ × 17"	390p	98p
4¾ × 17"	495p	275p
Pkt. of 100 pins		55p
Spot face cutter		150p
Pin insertion tool		185p

VQ Board	180
DIP Board	350
Vero Strip	374

PROTO DECs

Veroblock	405p
S-Dec	350p
Eurobreadboard	520p
Bimboard 1	575p
Superstrip SS2	1360p

VERO WIRING

PEN + spoool	**340p**
Spare spool	**75p**
Combs	**6p**

DALO ETCH RESIST PEN
Plus spare tip **90p**

FERRIC CHLORIDE
1 lb bag Anhydrous
195p + 50p P&P

ULTRASONIC TRANSDUCER
40KHz **325 pr**

COPPER CLAD BOARDS

Fibre glass	Single-sided	Double-sided	S.R.B.P.
6" × 6"	90p	110p	9.5" × 8.5"
6" × 12"	150p	195p	95p

DIL SOCKETS

	Low Prof	Wire Wrap
8pin	8p	25p
14pin	10p	35p
16pin	10p	42p
18pin	16p	52p
20pin	20p	60p
22pin	22p	65p
24pin	25p	70p
28pin	28p	80p
40pin	30p	99p

EDGE CONNECTORS

	.1	.156
2 × 15 way	—	140p
2 × 18 way	180p	145p
2 × 22 way	199p	200p
2 × 23 way	175p	—
2 × 25 way	225p	220p
2 × 28 way	190p	—
2 × 30 way	245p	—
2 × 36 way	295p	—
2 × 40 way	315p	—
2 × 43 way	395p	—
2 × 75 way	550p	—

ANTEX SOLDERING IRON

C-15W	455p	CX17W	475p
CCN-15W	495p	CX25W	510p
Spare tips, assorted sizes			65p
Spare Elements			210p
Iron stand with sponge			165p

SIL SOCKET
0.1" pitch
20 way
65p

IDC CONNECTORS

	PCB Plugs with latch Pins Strt	pins Angle	Female Header Plug	Female Card Edge Connect
10 way	90p	99p	85p	120p
16 way	130p	150p	110p	—
20 way	145p	166p	125p	195p
26 way	175p	200p	150p	240p
34 way	205p	236p	169p	320p
40 way	220p	250p	190p	340p
50 way	235p	270p	200p	395p
60 way	—	—	230p	495p

EURO CONNECTORS

	Female Socket Strt. Pins	Female Socket Angle Pins	Male Plug Strt. Pins	Male Plug Angle Pins
DIN41617 31way	170p	—	—	175p
DIN41612 2x32 A+B	275p	320p	220p	285p
DIN41612 2x32 A+C	295p	340p	240p	300p
DIN41612 3x32 A+B+C	360p	385p	260p	395p

DIL PLUG (Header)

	Solder	IDC
14pin	40p	99p
16pin	49p	105p
24pin	88p	178p
40pin	250p	255p

RIBBON CABLE
price per foot

	Grey	Color
10 way	15p	28p
16 way	25p	40p
20 way	30p	50p
24 way	40p	65p
34 way	60p	85p
40 way	70p	90p
50 way	85p	110p
64 way	100p	135p

ZIF DIL SOCKETS

24 pin	575p
28 pin	820
40 pin	975p

'D' CONNECTORS miniature

	9 way	15 way	25 way	37 way
MALE				
Solder lugs	80p	105p	160p	250p
Angle pins	150p	210p	250p	365p
PCB pins	120p	130p	195p	295p
FEMALE				
Solder lugs	105p	160p	200p	335p
Angle pins	165p	215p	290p	440p
PCB pins	150p	180p	240p	420p
COVERS	90p	85p	90p	100p
IDC 25way 'D' Plug				385p
Socket				450p

25way 'D' CONNECTOR RS232
Jumper Lead Cable Assembly

18" long, Single end, Male	495p
18" long, Single end, Female	525p
36" long, Double Ended, M/M	1025p
36" long, Double Ended, F/F	1050p
36" long, Double Ended, M/F	995p

● SPECIAL OFFER ●

2532 .... 285p
2764 .... 450p
6116 .... 375p
6522 .... 280p

PANEL METERS

FSD
60 × 46 × 35mm
0-50μA
0-100μA
0-500μA
0-1mA
0-5mA
0-10mA
0-50mA
0-100mA
0-500mA
0-1A
0-2A
0-25V
0-50V AC
0-300V AC
"S"
"VU"
425p each

CRYSTALS

32.768KHz	100
100KHz	235
200KHz	268
455KH	370
1MHz	275
1.008M	275
1.28MHz	392
1.6MHz	395
1.8NHz	395
1.8432M	200
2.0MHz	225
2.4576M	200
3.278M	150
3.5794M	98
3.6864M	300
4.0MHz	150
4.032MHz	290
4.80MHz	200
4.194304M	200
4.433619M	100
5.0MHz	160
5.185MHz	300
5.24288M	390
6.0MHz	140
6.144MHz	150
6.5536MHz	225
7.0MHz	150
7.168MHz	250
7.68MHz	200
8.0MHz	150
8.08333M	395
8.86723M	175
9.00MHz	150
10.0MHz	175
10.24MHz	200
10.7	150
12.0NHz	175
12.528M	300
14.31814M	170
16.0MHz	200
18.0MHz	180
18.432M	150
20.0MHz	200
19.968MHz	150
24.0MHz	170
24.930MHz	325
26.69M	150
27.648M	170
27.145M	190
38.66667M	175
48.0MHz	170
100.0MHz	295
116.0MHz	250

RELAYS

Miniature, enclosed, PCB mount.
SINGLE POLE Changeover
RL6-91 205 Ω Coil; 12 V DC (10V5 to 19.5 V). 10 A at 30 V DC or 250 V AC 185p
DOUBLE POLE Changeover. 6 A 30 V DC or 250 V AC
RL6-100 53 Ω Coil, 6 V DC (5V4 to 9V9) 190p
RL6-111 205 Ω Coil, 12 V DC (10V7 to 19V5) 195p
RL6-114 740 Ω Coil, 24 V DC (22 V to 37 V) 200 p

AMPHENOL PLUGS

IEEE 24 Way	550
Centronics Parallel 36 Way solder	530
Centronic Parallel 36 way IDC	495

BUZZERS, miniature, solid-state 6V: 9V & 12V 70p

PIEZO TRANSDUCERS
PB2720 55p

LOUDSPEAKERS
Miniature, 0.3W: 8Ω

2in, 3¼in, 2½in, 3in	80p
2½in 40Ω, 64Ω or 80Ω	80p

ASTEC UHF MODULATORS

Standard 6 MHz	350p
Wideband 8 MHz	480p

'WEMON' New Version WATFORD'S Ultimate Monitor IC

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BBC Micro Mod-A	£299
Mod-B	£399
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Complete Printer Cable 36"	£12
Disc Interface Kit	£65
Analogue I/O Kit	£6.45
Serial I/O Kit	£6.70
Expansion Bus Kit	£6.10
Complete Upgrade Kit from Model A to Mod. B	£43

We supply complete range of BBC Plugs, Sockets, Leads, Peripherals, Software etc. Send SAE for list

RANSFORMERS:

-3V; 6-0-6V; 9-0-9V; 12-0-12V; 15-0-15V
100mA **98p**
› mounting. Miniature, Split Bobbin
A: 2x6V-0.25A; 2x9V-0.15A; 2x12V-0.12A; 5V-0.1A **200p**
A: 2x6V-0.5A; 2x9V-0.3A; 2x12V-0.25A; 5V-0.2A **270p**
ndard Split Bobbin type:
A: 2x6V-0.5A; 2x9V-0.4A; 2x12V-0.3A; 5V-0.25A **220p**
'A: 2x4.5V-1.3A; 2x8V-1A; 2x9V-0.6A; 2V-0.5A; 2x15V-0.4A; 2x20V-0.3A **295p** (35p p&p)
'A: 2x6V-1.5A; 2x9V-1.2A; 2x12V-1A; 5V-0.8A; 2x20V-0.6A **330p** (60p p&p)
'A: 2x6V-4A; 2x9V-2.5A; 2x12V-2A; 2x15V-A; 2x20V-1.2A; 2x25V-1A; 2x30V-0.8A **465p** (60p p&p)
cially wound for Multirail Computer PSUs
'A: Outputs +5V/5A; +12V, +25V, −5V, 2V at 1A 575p (60p p&p)
VA: 2x12V-4A; 2x15V-3A; 2x20V-2.5A; 5V-2A; 2x30V-1.5A; 2x50V-1A **920p** (75p › charge to be added over and above our nor- postal charge).

VOLTAGE REGULATORS

1A	TO220 +ve		Plastic −ve	Casing
5V	7805	40p	7905	45p
12V	7812	40p	7908	60p
15V	7815	40p	7912	45p
18V	7818	40p	7915	45p
24V	7824	40p	7918	45p
			7924	45p

100mA TO92 Plastic package

5V	78LO5	30p	79LO5	60p
6V	78LO6	30p	—	
8V	78LO8	30p	—	
12V	78L12	30p	79L12	60p
15V	78L15	30p	79L15	60p

LM300H	170p	TAA550	50p
LM304H	170p	TDA1412	150p
LM305H	140p	78H05 +5V/5A	550p
LM309K	135p	78H12 +12V/5A	
LM317K	320p		580p
LM317KP	99p	78HG +5V to +25V	
LM323K	460p	5A	599p
LM337	175p	79HG +2.25V to 24V	
LM723 Var	36p	5A	685p

SOLDERCON PINS

Ideal for making SIL or DIL Sockets

100 pins	75p
500 pins	350p

ALUM BOXES

3 × 2 × 1"	65p
4 × 2¼ × 2"	85p
4 × 2¾ × 2½"	103p
4 × 4 × 2"	105p
4 × 4 × 2½"	120p
5 × 4 × 1½"	99p
5 × 4 × 2½"	120p
5 × 2¾ × 1½"	90p
5 × 2¾ × 2½"	130p
6 × 4 × 2"	120p
6 × 4 × 3"	150p
7 × 5 × 3"	180p
8 × 6 × 3"	210p
10 × 4 × 3"	240p
10 × 7 × 3"	275p
12 × 5 × 3"	260p
12 × 8 × 3"	295p

MOS

10
10
12
50
14
32
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24
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16
20
46
40
20
32
45
25
42
40
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80
20
39
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125
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125
140
46
275
115
110
250
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40
105
46
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40
25
25
45
60
50
85
86
85
1915
435
45
1195
995
86
24
245
14
16
13
13
13
15

4075	13
4076	50
4077	13
4078	15
4081	13
4082	13
4085	50
4086	80
4089	125
4093	20
4094	70
4095	95
4096	70
4097	290
4098	75
4099	110
4160	95
4161	99
4162	99
4163	99
4174	99
4175	105
4194	105
4408	790
4409	790
4410	725
4411	675
4412	775
4415	480
4419	280
4422	770
4435	850
4440	999
4450	350
4451	350
4490	350
4500	675
4501	28
4502	60
4503	40
4504	75
4505	185
4506	35
4507	35
4508	130
4510	46
4511	45
4512	50
4513	199
4514	115
4515	115
4516	55
4517	275
4518	40
4519	30
4520	50
4521	90
4522	125
4526	70
4527	85
4528	70
4529	150
4530	90
4531	130
4532	70
4534	400
4536	275
4538	80
4539	90

4541	140
4543	70
4544	150
4548	40
4549	375
4553	246
4554	190
4555	36
4556	36
4557	320
4558	120
4559	396
4560	160
4561	104
4562	495
4566	165
4568	250
4569	175
4572	36
4580	460
4581	260
4582	99
4583	90
4584	40
4585	60
4597	330
4599	290
40085	90
40097	45
40098	42
40100	215
40101	130
40102	140
40103	175
40104	95
40105	105
40106	35
40107	80
40108	198
40109	80
40110	198
40114	240
40161	194
40163	50
40174	45
40175	50
40181	220
40182	90
40192	75
40193	70
40194	70
40195	75
40244	196
40245	196
40257	196
40373	160
40374	160
45106	596

OPTO

LS400C	255
OCP71	120
ORP12	86
ORP61	85
2N5777	45
BPX25	195
BPW21	295
BPX65	270

OPTO ELECTRONICS

LEDs with Clips	
TIL209 Red	10
TIL211 Grn	14
TIL212 Yel.	14
TIL220 .2" Red	12
.2" Green, Yellow or Amber	14
0.2" Bi colour Red/Green	65
Green/Yellow	78
0.2" Tri colour Red/Green/Yellow	85
Hi-Brightness Red	59
Flashing red 0.2" red	55
Square LEDs, Red, Green, Yellow	30
Rectangle Stackable LEDs Red, Green or Yell	18
Triangular LEDs Red	18
Green or yellow	22
LD271 Infra Red	46
SFH205 Detector	118
TIL32 Infra Red	58
TIL78 Detector	60
TIL38	45
TIL100	80
BARGRAPH. Red 10 segments	225
ISOLATORS	
IL74	55
ILD74	99
ILQ74	185
TIL111/2/4	90
TIL117	125
4N33 Photo Darlington	135
7 Segment Displays	
TIL312 .3" CA	105
TIL313 .3" CC	105
TIL321 .5" CA	115
TIL322 .5" CC	115
DL704 .3" CC	99
DL707 .3" CA	99
FND357 Red	120
FND500	115
.3" Green CA	150
.6" Green CA	215
.3" ± 1 Red CA	150
.3" ± 1 Green CA	150
DVM176	£22
LCD 3½ Digits	495
LCD 4 Digits	530
LCD 6 Digits	625

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Rectangular, nut fixing Red, Amber, Green 30p
REFLECTIVE Optical Switch type TIL139 170p
SLOTTED Optical Switch similar to RS Comp.'s 186p

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- **ELECTRONIC TIMER**, Solid State, 15-30 min. Connects directly to above Erasers. Protects your expensive Chips from overcooking. Our timer pays for itself in no time **£15**
- **SPARE** 'UV' Lamp bulb **£8**
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- **MULTIRAIL POWER SUPPLY KIT**. Especially designed for Micros. Tested output: +5 V/5 A; +12 V; +25 V; −12 V of 1 A **£37**
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- **SEIKOSHA GP250X**. 10", 50 CPS, Normal and Double width and height Char. RS232 and Centronics Intrf. standard **£240** (£7 carr)
- Printer Cable for our printers and BBC MICRO **£12**

height Char. RS 232 and Centronics Intrf. standard **£240** (£7 carr)

- Printer Cable for our printers and BBC **£12**

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- CS50E — Single Cased with PSU, 80 track, 5¼" S/S 200K **£250**
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Europe's most popular Printer

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A highly sophisticated Acorn Utility ROM. Plugs straight into floating point Atom's Utility socket. Gives many unique BASIC Extensions: Hi-speed Tape Interface, 2 Key rollover Keyboard, Full disassembler, Memory dump modify, Machine code breakpoints; Basic error trapping: READ, DATA & RESTORE: Full BASIC Keyboard scanner, (BBC like): Find line & delete; Auto line numbering; Plus: Chain, Cursor movement, Loop aborting; Easily extendible further.
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6502	350p
6522	340p
6800	290p
68B00	450p
6802	345p
6809	845p
68B09	1350p
6809E	1295p
6810	120p
6821	160p
68B21	215p
6840	390p
68B40	580p
6844	1295p
6845	795p
6850	140p
6852	250p
6854	680p
6875	490p
8T26A	120p
8T28	120p
8T95	90p
8T96	90p
8T97	90p
8T98	90p
8035L	340p
8039L	290p
8080A	360p
8085A	450p
8155	450p
8212	155p
8216	100p
8224	160p
8226	195p
8228	250p
8243	210p
8251	300p
8253	450p
8255	280p
8257	450p
8259	450p
8279	450p
75451	65p
75452	65p
75491	70p
75492	70p
AY-3-1015D	300p
AY-5-1013A	300p
MC1408	295p
MC1488	55p
MC1489	55p
MC3459	295p
Z80ACPU	350p
Z80APIO	300p
Z80ACTC	300p
Z80ADART	750p

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2114L	90p
2716	210p
2532	380p
2732	380p
4116	85p
4164	500p
6116	450p
6116L	480p

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AY-3-1350	350p
AY-3-8910	435p
AY-3-8912	620p
AY-5-1230	450p
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741 14 pin	25p
741S	55p
747	65p
748	35p
CA3080E	70p
CA3130E	75p
LA4422	295p
LF355	80p
LF356	90p
LF357	100p
LM301A	26p
LM307	50p
LM308A	95p
LM311N	66p
LM324	35p
LM339	50p
LM348	75p
LM358	60p
LM380	95p
LM381	150p
LM393	90p
LM3909	85p
MC1310P	210p
MC1455	66p
MC1456	135p
MC1458	35p
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MC3340	120p
MC3401	65p
MC3403	70p
MC3456	107p
MC3480	580p
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NE556	56p
NE565	155p
NE567	140p
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TBA800	90p
TBA920	190p
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TCA910	180p
TDA1004	290p
TL061	40p
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TL064	98p
TL071	30p
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TL082	45p
TL084	95p
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UPC1167	158p
UPC2002C	285p
UPD7002	450p
ZN414	100p

VOLTAGE REGULATORS

+ Ve	
100mA	
78L05	30p
78L08	30p
78L12	30p
78L15	30p
500mA	
78M05	40p
78M06	55p
78M08	55p
78M12	50p
78M15	50p
78M18	55p
78M24	55p
1A	
7805	45p
7806	65p
7808	65p
7812	45p
7815	45p
7818	65p
7824	65p
– Ve	
100mA	
79L05	35p
79L12	35p
79L15	35p
1A	
7905	60p
7906	70p
7908	70p
7912	60p
7915	60p
7918	60p
7924	60p

TRANSISTORS

BC107	12p
BC107B	15p
BC108	12p
BC108B	15p
BC109	12p
BC109B	15p
BC109C	15p
BC147	9p
BC157	9p
BC158	9p
BC177	25p
BC178	25p
BC179	25p
BC182	10p
BC182A	10p
BC182B	10p
BC183A	10p
BC183C	10p
BC184	10p
BC184C	10p
BC212	10p
BC212A	10p
BC212B	10p
BC213A	10p
BC213C	10p
BC214	10p
BC214C	10p
BC237A	12p
BC237C	12p
BC238	12p
BC238A	12p
BC238B	12p
BC238C	12p
BC239	12p
BC307A	15p
BC307C	15p
BC308	15p
BC308A	15p
BC308B	15p
BC308C	15p
BC309	15p
BC309C	15p
BC327	15p
BC328	15p
BC337	15p
BC338	15p
BC477	28p
BCY70	18p
BCY71	20p
BCY72	20p
BD135	42p
BD136	45p
BD139	40p
BD140	40p
BD165	45p
BD166	45p
BD169	45p
BD170	45p
BD538	95p
BD677	60p
BD678	60p
BD679A	60p
BD680A	65p
BFY50	24p
BFY51	24p
BFY90	85p
BF244A	30p
BSX19	28p
BSX20	20p
MJ2955	95p
MJE241	80p
MJE251	80p
MJE340	50p
MJE350	90p
MJE370	95p
MJE520	90p
MJE2955	90p
MJE3055	65p
MPF102	45p
MRF475	290p
MPS2369	25p
MPS3640	30p
MPS3646	30p
MPSA06	20p
MPSA12	35p
MPSA13	20p
MPSA14	20p
MPSA18	20p
MPSA27	45p
MPSA42	25p
MPSA56	25p
MPSA63	30p
MPSA64	45p
MPSA77	50p
MPSA92	30p
TIP29	35p
TIP29A	35p
TIP29B	55p
TIP29C	40p
TIP30	50p
TIP30A	35p
TIP30B	50p
TIP30C	40p
TIP31A	40p
TIP31B	42p
TIP31C	45p
TIP32	50p
TIP32A	45p
TIP32B	60p
TIP32C	45p
TIP33	65p
TIP33A	65p
TIP33B	70p
TIP33C	75p
TIP34	75p
TIP34A	75p
TIP34B	99p
TIP34C	90p
TIP35	160p
TIP35A	165p
TIP35B	170p
TIP35C	185p
TIP36	170p
TIP36A	175p
TIP36B	185p
TIP36C	199p
TIP41	50p
TIP41A	50p
TIP41B	60p
TIP41C	50p
TIP42	58p
TIP42A	60p
TIP42B	75p
TIP42C	65p
TIP47	50p
TIP48	50p
TIP49	50p
TIP50	48p
TIP110	30p
TIP111	75p
TIP112	50p
TIP115	40p
TIP116	73p
TIP117	45p
TIP120	39p
TIP121	80p
TIP122	75p
TIP125	45p
TIP126	80p
TIP140	130p
TIP141	140p
TIP142	180p
TIP145	140p
TIP146	180p
TIP147	170p
TIP2955	70p
TIP3055	70p
TIS43	30p
TIS88A	48p
TIS151	50p
2N1613	25p
2N1711	25p
2N1893	35p
2N2218A	45p
2N2219	25p
2N2221	30p
2N2221A	30p
2N2222	25p
2N2222A	25p
2N2369A	20p
2N2904A	25p
2N2905	25p
2N2905A	25p
2N2906A	25p
2N2907A	25p
2N3053	30p
2N3054	70p
2N3055	45p
2N3439	80p
2N3440	60p
2N3771	160p
2N3772	160p
2N3773	250p
2N3819	25p
2N3821	120p
2N3822	120p
2N3823	95p
2N3824	95p
2N3866	90p
2N3903	15p
2N3904	15p
2N3905	15p
2N3906	15p
2N4123	25p
2N4125	25p
2N4391	70p
2N4392	70p
2N4400	20p
2N4401	25p
2N4402	25p
2N4403	25p
2N4410	45p
2N4416	95p
2N4856	80p
2N4857	80p
2N4918	95p
2N4919	120p
2N4920	130p
2N4921	105p
2N4922	95p
2N4923	96p
2N5190	75p
2N5191	75p
2N5192	75p
2N5193	90p
2N5194	90p
2N5195	90p
2N5400	40p
2N5401	40p
2N5415	85p
2N5416	90p
2N5457	35p
2N5458	35p
2N5459	35p
2N5460	35p
2N5551	40p
2SC495	60p
2SC1306	95p
2SC1678	105p
2SC2028	75p
2SC2078	105p
VN10KM	65p
40673	95p

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Reset Capability
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Prescaler Available
Incandescent Backlighting
Supply Voltage 5v
Operating Current 4mA
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3½ Digits, 0.5"
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200mV Full Scale Input
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EC942	0.039" Lines
EC943	0.049" Lines
EC944	0.061" Lines
EC945	0.079" Lines
EC946	0.100" Lines
EC947	0.124" Lines
EC950/1	0.031" 90° Bends
EC950/2	0.061" 90° Bends
EC952/1	0.031" 30°,45°,60° Bends
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d.c. Amps:-	0.2mA – 2mA – 20mA – 200mA ± 1.2%; 10A ± 2%	Transistor check:-	h_{FE} 0 – 1000 PNP or NPN; I_{BE} 10uA, V_{CE} 2.8V.
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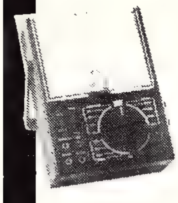

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Resistance: 0-2K-20K-200K 0-2M-20M ±3%

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AC Volts: 0-10v-50v-250v-1000v ±3%
DC Current: 0.50uA-2.5mA-25mA-0.25A ±3%
Resistance:
min 0.2-2-200-200k ohms ±3%
mid 20-200-20k-200k ohms ±3%
max 2k-20k-2m-20m ohms ±3%
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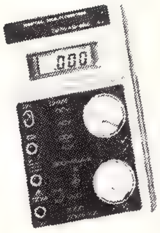

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DC Volts: 200mV, 2V, 20V, 200V and 1000V ±0.8% of rdg.
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DC Current: 200uA, 2mA, 20mA, 200mA ±1.5% of rdg.
1000mA (1A), 10A ±3% of rdg.
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1000mA (1A), 10A ±3% of rdg.
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200M ±3% of rdg.
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AC A: 0.5mA-50mA-500mA-10A
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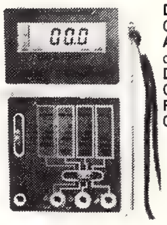

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£29.95

DC Volts: 0-2V, 0-20V, 0-200V, 0-1000V ±1% of reading
AC Volts: 0-200V, 0-500V ±2% of full scale
DC Current: 0.2mA, 0-20mA, 0-200mA ±1.5% of reading
Resistance: 0-2K, 0-20K, 0-200K, 0-2M ±1.5% of reading

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MK6	Transmitter for above	**£ 4.20**
TD300K	Touchdimmer	**£ 7.00**
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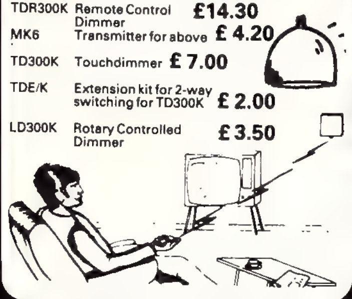
LD300K	Rotary Controlled Dimmer	**£ 3.50**



HOME CONTROL CENTRE

This New Remote Control Kit enables you to control up to 16 different appliances anywhere in the house from the comfort of your armchair. The transmitter injects coded pulses into the mains wiring which are received by receiver modules connected to the same mains supply and used to switch on the appliance addressed. Receivers are addressed by means of a 16-way keyboard, followed by an on or off command. Since pushing buttons can become rather boring, the transmitter also includes a computer interface so you can programme your favourite micro to switch lights, heating, electric blanket, make your coffee in the morning, etc., without rewiring your house. JUST THINK OF THE POSSIBILITIES. The KIT includes all PCBs and components for one transmitter and two receivers, plus a drilled box for the transmitter.
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Additional Recievers XK111 £10.00

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This KIT contains a purpose designed lock IC, 10-way keyboard, PCBs and all components to construct a Digital Lock, requiring a 4-key sequence to open and providing over 5000 different combinations. The open sequence may be easily changed by means of a prewired plug. Size: 7 x 6 x 3 cms. Supply: 5V to 15 V d.c. at 40uA. Ouput: 750mA max. Hundreds of uses for doors and garages, car anti-theft device, electronic equipment, etc. Will drive most relays direct. Full instructions supplied.

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MK2 Solid State Relay
Ideal for switching motors, lights, heaters, etc. from logic. Opto-isolated with zero voltage switching. Supplied without triac **£2.60**

MK3 BAR/DOT DISPLAY
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Based on the SAB0600 IC the kit is supplied with all components, including loudspeaker, printed circuit board, a pre-drilled box (95 × 71 × 35mm) and full instructions. Requires only a PP3-9V battery and push-switch to complete. AN IDEAL PROJECT FOR BEGINNERS. Order as XK102 **£5.00**

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Based on ZN414 IC, kit includes PCB, wound aerial and crystal earpiece and all components to make a sensitive miniature radio. Size: 5.5 × 2.7 × 2cms. Requires PP3 9V battery. IDEAL FOR BEGINNERS. **£5.00**

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This new design is based on the ICL7126 (a lower power version of the ICL7106 chip) and a 3½ digit liquid crystal display. This kit will form the basis of a digital multimeter (only a few additional resistors and switches are required—details supplied), or a sensitive digital thermometer (−50°C to +150°C) reading to 0.1°C. The basic kit has a sensitivity of 200mV for a full scale reading, automatic polarity indication and an ultra low power requirement—giving a 2 year typical battery life from a standard 9V PP3 when used 8 hours a day, 7 days a week.

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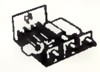

DL 1000K
This value for money kit features a bi-directional sequence, speed of sequence and frequency of direction change, being variable by means of potentiometers and incorporates a master dimming control **£14.60**

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A lower cost version of the above, featuring undirectional channel sequence with speed variable by means of a pre-set pot. Outputs switched only at mains zero crossing points to reduce radio interference to a minimum. **Only £8.00**

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Allowing audio ("beat") - light response. **60p**

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MK8 CODED INFRA RED TRANSMITTER
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For use with MK8 and MK18 to generate 16 different codes for decoding by the ML928 or ML926 receiver (MK12) kit. **£5.40**

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Based on ML922 decoder IC. Functions include on/standby output, toggle, control of volume, tone and lamp brightness. Includes its own mains supply. **£12.00**

MK12 16-CHANNEL IR RECEIVER
For use with MK8 kit with 16 on/off outputs, which with further interface circuitry, such as relays or triacs, will switch up to 16 items of equipment on or off remotely. Latched or momentary outputs – please specify when ordering. Includes its own mains supply. **£11.95**

MK13 11-WAY KEYBOARD For use with MK8, MK18 and MK11 kits. **£4.35**

MK16 Mains Powered IR Transmitter
Mains powered for continuous operation – single channel, for applications such as burglar alarms, automatic door openers, etc. Range approx. 6 ft. **£2.50**

MK17 12V d.c. IR RECEIVER
For use with MK6 or MK16. Relay output with DP 3 Amp change-over contacts, may be used as latched, momentary or "break beam" receiver. Operates from 6-13V d.c. **£9.50**

MK18 HIGH POWER IR TRANSMITTER
Similar to MK8 but with range of approx. 60ft. **£6.20**

Ancillary Kits : MK2 Solid State Relay
Opto-isolated with zero voltage switching. No. triac supplied. **£2.60**

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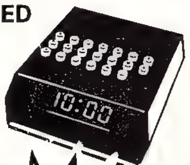

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* Useful "sleep" function–turns on output for one hour.
* Direct switch control enabling output to be turned on immediately or after a specified time interval.
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(Kit includes all components, PCB, assembly and programming instructions). ORDER AS CT5000

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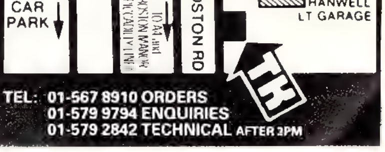
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services to readers

EPS print service

Many Elektor circuits are accompanied by printed circuit designs. Some of these designs, but not all, are also available as ready-etched and pre-drilled boards, which can be ordered from any of our offices. A complete list of the available boards is published under the heading 'EPS print service' in every issue. Delivery time is approximately three weeks.

It should be noted however that only boards which have at some time been published in the EPS list are available; the fact that a design for a board is published in a particular article does not necessarily imply that it can be supplied by Elektor.

Technical queries

Please enclose a stamped, self-addressed envelope; readers outside UK please enclose an IRC instead of stamps.

Letters should be addressed to the department concerned – TQE (Technical Queries). Although we feel that this is an essential service to readers, we regret that certain restrictions are necessary:

1. Questions that are not related to articles published in Elektor cannot be answered.
2. Questions concerning the connection of Elektor designs to other units (e.g. existing equipment) cannot normally be answered. An answer can only be based on a comparison of our design specifications with those of the other equipment.
3. Questions about suppliers for components are usually answered on the basis of advertisements, and readers can usually check these themselves.
4. As far as possible, answers will be on standard reply forms.

We trust that our readers will understand the reasons for these restrictions. On the one hand we feel that all technical queries should be answered as quickly and completely as possible; on the other hand this must not lead to overloading of our technical staff as this could lead to blown fuses and reduced quality in future issues.

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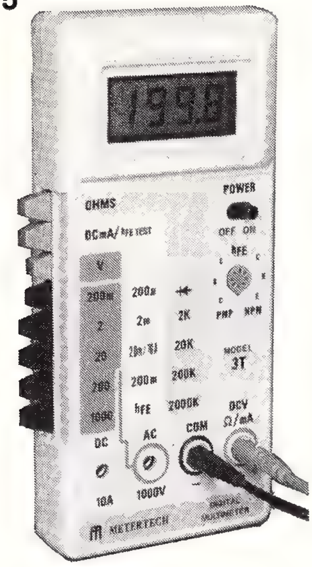

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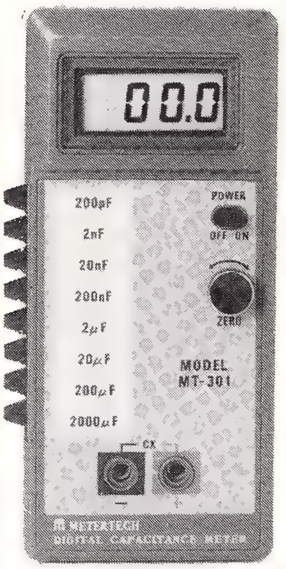

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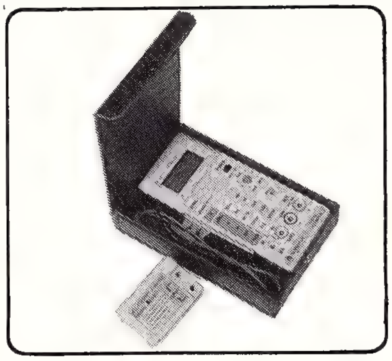

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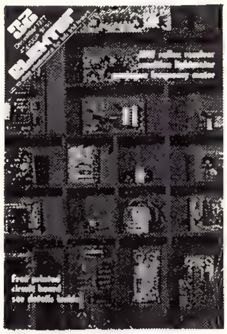
back number service

E24, April 1977
Formant – The Elektor Synthesiser/Slotless Model Car Track (1)/Morse Decoder with ddll (2)/Digisplay on Board/LED VU/PPM/Signal Injector/Simple Auto Slide Changer/Hinil Drive for Light Sequencer / Variometer Tuner (2)/Albar Mk 11 – a.b.f.s.

E29, September 1977
Introducing Microprocessors (1)/FM Mains Intercom/Working Perspex/Logarithmic Darkroom Timer/Monitor Switching for Two Tape Decks/CCIR TV Pattern Generator (1)/Formant – the Elektor Music Synthesiser (3).

E32, December 1977
Analogue Frequency Meter/Experimenting with the SC/MP (2)/Djolly Djingle Djenerator/Electret Microphone Preamplifier/ UHF TV Modulator/ Formant – the Elektor Music Synthesiser (6)/Heating Controller/Stylus Balance/Signal Injector/Knotted Handkerchief/Sensitive Lightmeter/MW Reflex Receiver/Music Box.



E33, January 1978
CMOS Noise Generator/Elektor Equaliser/Tar-tip/Electronic Open Fire / Peak Programme Meter/UAA 180 LED Voltmeter/Experimenting with the SC/MP (3)/Formant – the Elektor Music Synthesiser (7)/Simple Function Generator.

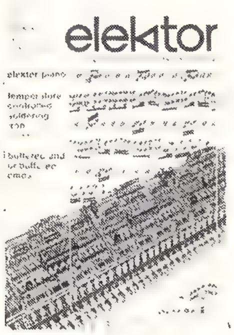
E34, February 1978
Infra-red Light Gate/Throwing Some Light on LEDs/Formant – the Elektor Music Synthesiser (8)/Slow on/off/CMOS Function Generator/Zener Tester/Development Timer/Experimenting with the SC/MP (4).

E35, March 1978
Experimenting with the SC/MP (5)/SC/MP Power Supply/Car lights Failure Indicator/Colour TV Games/4 K RAM Card/Fun with a RAM/Electronic Maze/Formant – the Elektor Music Synthesiser (9)/Safety First.

E37, May 1978
Aerial Systems for Satellite Communication/Digital Reverberation Unit/Mini Short-wave Receiver/Vocoder (2)/Percolator Switch/Colour Modulator/ Circuit Boards and Soldering/Universal Logic Tester.

E38, June 1978
1/4 GHz Counter/Constant Amplitude Squarewave to Sawtooth Converter/Servo Polarity Changer/ Monopoly Dice/ Mini Counter/Digital Clock Using the SC/MP/Programmable Call Generator/TV Sound Modulator/Automatic Stereo Switch/Traffic Light Controller/Easy Music.

E41, September 1978
Puffmeter/ Oscillographics/ One Chip Does Not Make a Piano/Master Tone Generator/Piano/Temperature-controlled Soldering Iron/Car Start Booster/24 dB VCF/Buffered/Unbuffered CMOS.

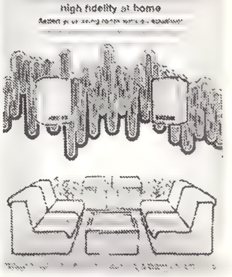


E43, November 1978
Cackling Egg-Timer/ASCII Keyboard/Tag/ Joysticks/ Digiscope/Ring the Bell and Win a Prize/Extending the TV Scope/15 Duty-cycles at the Turn of a Switch/Hello, All You Folks Back Home/SC/MP 'Mastermind' TM Programme / Pocket Bagatelle.

E48, April 1979
µP TV Games/Car Light Reminder/Stentor/TAP Switch/Assistentor/Zero pF Screen/Quiz Master/Building the TV Games Computer.

E49, May 1979
Programmable Timer/Controller/Switching Mains-powered Equipment/Random Tune Doorbell/Delay Lines (2)/CAPITALS from the ASCII Keyboard/Interface for µPs/Sweep Generator/Simple Sound Effects/BASIC Microcomputer/NIBL-E/Musical Doorbell.

E50, June 1979
Nicads/Elekdoorbell/Stereo Decoder/VHF Stereo Test Transmissions/Variable Logic Gate/FM IF Strip/Goodbey E300/E310, Hello J300/J310/Aquarium Thermostat/Monoselektor/Right-up and Left-down.



E53, September 1979
Using an Equaliser/Monitor Output/Page Extension for Elekterminal/One-nil for Audio/Parametric Equaliser/Audio Analyser /TAP Thieves on the Head.

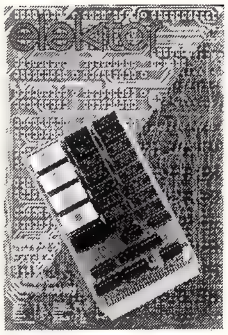
E54, October 1979
Touch Tuning/Battery Saver/Impedance Bridge/New Programs for the SC/MP/Digital Rev Counter/Digifarad/Short-interval Light Switch/PCB for Variable Fuzz Box/Gate-dipper/Strain Gauge/I Played TV Games/Programmable Sequencer.

E55, November 1979
Topamp/Flash Sequencer/Electronics the Easiest Way/Remote Control Motor Switch/Home Trainer/Fuel Economiser/I Played TV Games (2)/Shortwave converter/Ionosphere/Low Voltage Dimmer/I See your Point/Servo-controlled Motor.

E58, February 1980
Aerial Booster/Fet Opamps in the Formant/TV Interference Suppression / Elektor Vocoder (2)/Aerial Amplifiers/Digisplay/Analogue Delay Technology/Extending the 1/4 GHz Counter/Digital Thermometer.

E63/64, July/August 1980
Summer Circuits Double Issue containing over 100 projects.

E65, September 1980
8K RAM +4.8 or 16K EPROM on a Single Card/Precision Power Unit/Electronic Linear Thermometer/The Josephson Computer/VOX Printed Circuit Board/Ejektor: Measuring Multipath/High Speed Readout for Elekterminal/Musical Box/Electrolytology/Curve Tracer/Using the Vocoder.

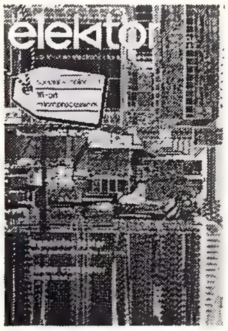


E66, October 1980
Programmable Slide Fader/Touch Doorbell/Switched Capacitors/More TV Games/The Junior Computer Memory Card/Remote Control Slide Projector/Video Pattern Generator/LCD Tuning Scale/Dual Slide Faders.

E67, November 1980
An r.p.m. Indicator as an Economy Guide/Draught Detector/How to Recycle Dry Cell Batteries/Energy Saving Knowhow/Simple Fuel Economy Meter/Automatic Pump Control /Long Life Technique in Light Bulbs/Automatic Curtain Control/Fridge Alarm/Know the ins and outs of your Central Heating System/Energy Saving Motor Control/Coffee Machine Switch/Operational Hours Counter.

E68, December 1980
Canned Circuits: 23 of the best entries which include Midnight Raid Detector/A 'Flash in the Can' / Canometer / Canine Defence.

E70, February 1981
Audio Power Meter/Noise Reduction / Process Timer / High voltage from 723 / Juniors Growing Up/The Voiced/Unvoiced Detector / Emergency Brake for the Power Supply/150 W DC to DC Converter for the Car/Low Noise 2 Metre Pre-Amp/2½ Digit DVM/Wagnephon.

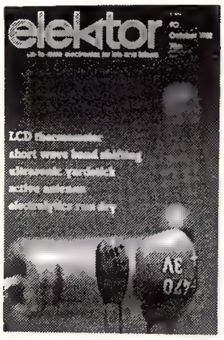


E72, April 1981
Transistor Match-maker/Universal Power Supply/Intelekt/Humidity Sensor/Logic Analyser II/Crystal-controlled Stroboscope/Junior Cookbook.

E73, May 1981
Camping Clock / Frequency Doubler/The Fully Fledged Junior Computer/Talk to Computers/Choke Alarm/Bar Codes/Logic Analyser/Waveform Generator/Sophisticated Software for the Junior Computer/Reading Bar Codes.

E77, September 1981
DFM + DVM/Revolution Counter/Digital Barometer/dB Converter/TV Games Extended/Disco Lights Controller/QUAD ESL 63/Analogue LED Display/Volt/Ammeter for Power Supplies/Chattering Chips/Transistor Ignition Update/Soldering Aluminium.

E89, September 1982
Gas Detector/Rapid Loading Games/The Elektor Connection/Inductive Sensor / Darkroom Computer Part 1 / Applikator/Home Telephone System/Synthesised Sound Animation/Time Receiver for the Rugby MSF/Three Phase Tester.



E90, October 1982
DSB Demodulator/L.C.D. Thermometer/Ultra Sonic Distance Measurement/Electrolytics Run Dry/Darkroom Computer Part 2/Short Wave Band Shifting for SSB Receiver/16 Channels with only Five ICs/Pre-amp for the SSB Receiver / Active Aerial / Transistor and IC Data.

E91, November 1982
Drum Interface/Talking Dice/Model Train Lighting/Guitar Tuner/Cerberus/Floppy Disc Interface for the Junior/Cubular Bell/Mini-Organ Extension/Kitchen Timer.

E92, December 1982
Triopede/Precision Power Supply/The XL System/Crescendo/Home Telephone Help/Soft Switching/In-car Ioniser/Floppy Disc Interface for the Junior Part II/A Dozen and One Sounds /Stop-signal Override for Model Railways.

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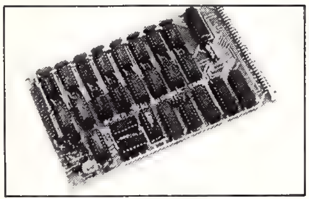
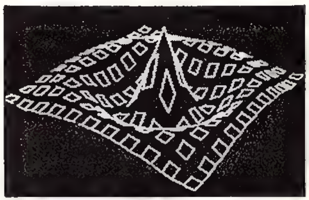


Expansion Cards



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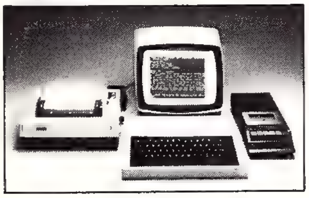

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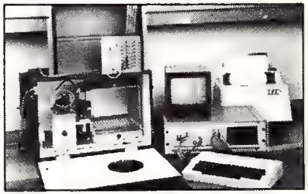

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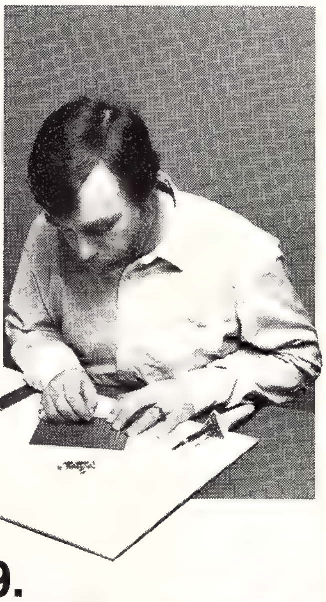

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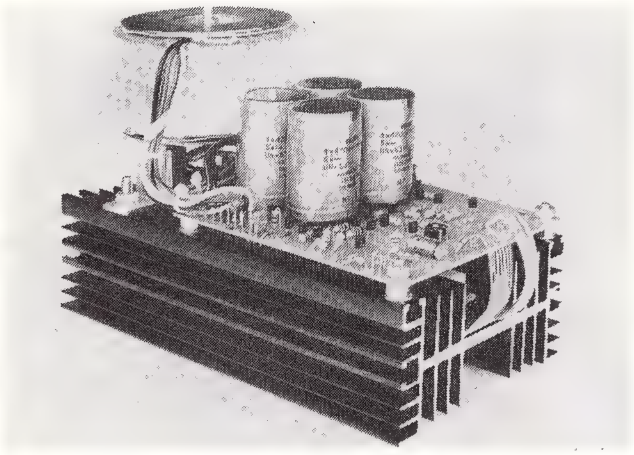

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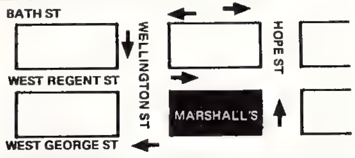

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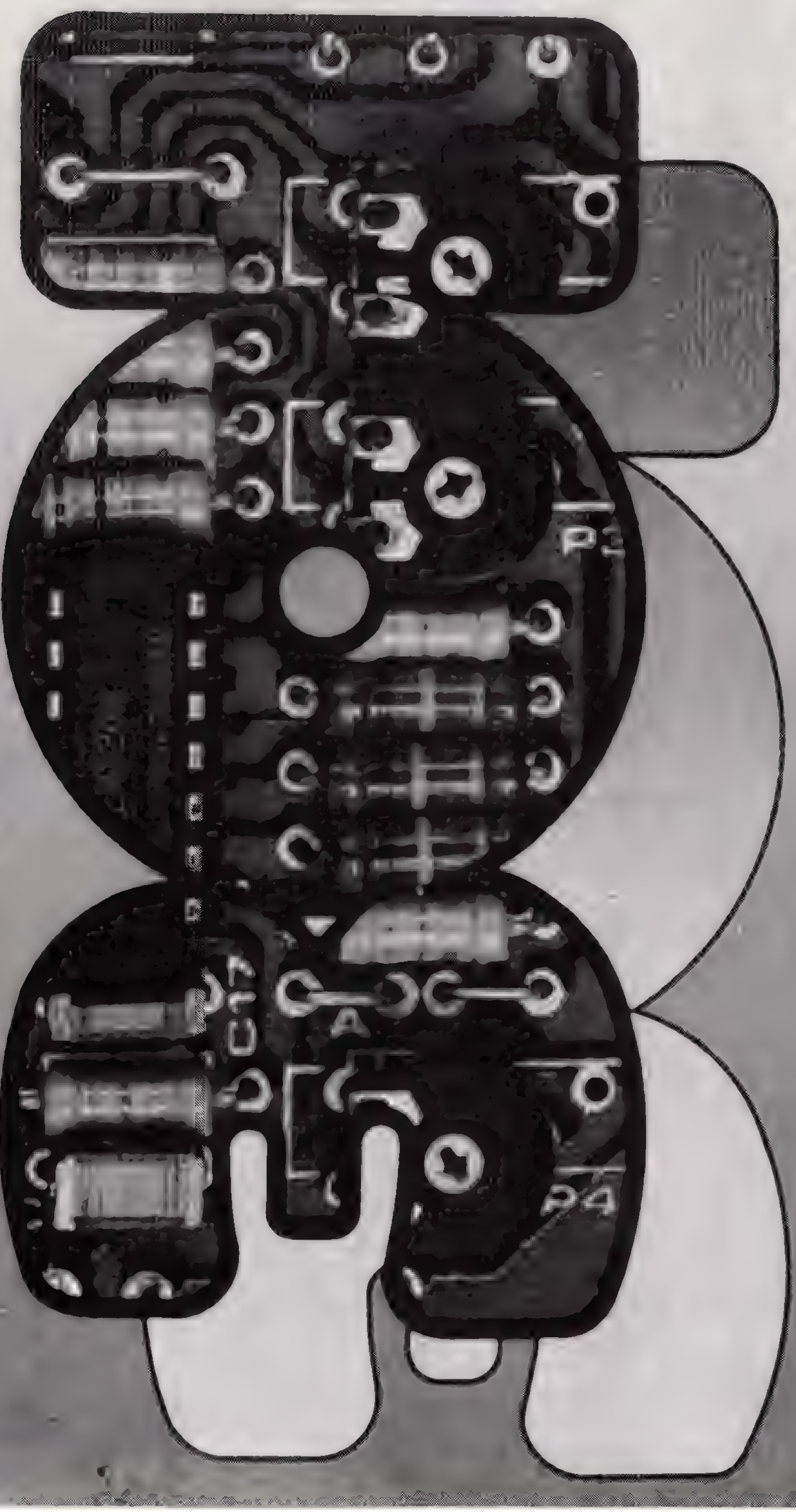

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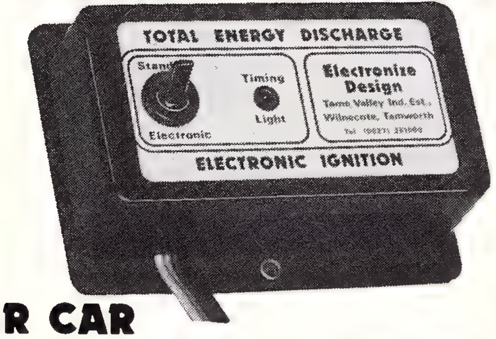

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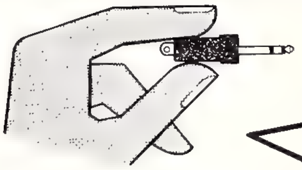

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The potential of the bucket brigade

Charge-coupled devices, or CCDs as they are usually called, have evolved through semiconductor technology. Electronics engineers and technicians often think of them as 'bucket-brigade' elements in a circuit, from the way they work. But CCDs are making a remarkable contribution to such highly sophisticated fields as astronomy and particle physics. Because they are semiconductor devices, CCDs are robust, consume little power, have a long life and are compact. The unit of length used in describing them is the micrometre, and the extremely small dimensions must be remembered when looking at explanatory diagrams which have to be drawn large. Discussions range round charges of, say, only a thousand or so electrons, whereas a normal *n*-type doped silicon has some 10^{12} electrons per cubic millimetre. With CCDs we are in a minute world of microscopic size. Indeed, devices can have hundreds of thousands of unit cells on a chip hardly more than a square centimetre in area.

Furthermore, the manufacturing technology is simpler than that for integrated circuits, because it involves very few successive stages. It is based largely on well-known techniques used in making field-effect transistors.

The basic, simplified CCD is outlined in figure 1, where (a) represents two CCD units, A and B. There is a charge of electrons in A. If the voltage on A is reduced to nothing and that on B is raised, the electrons travel through the *n*-type channel towards B. In this way the charge is 'coupled' or transferred between A and B. Part (b) is a somewhat more realistic side-elevation, showing the silicon *p*-type substrate (which has a deficit of electrons) on the top of which is a very thin *n*-type layer. Over this is an insulation layer of silicon dioxide. Above them all there are the conducting electrodes, which overlap but are insulated from one another. Depending on the purpose of the device, the thickness of the substrate may be from 35 to 300 μm and the *n*-type layer may be only a few micrometres thick.

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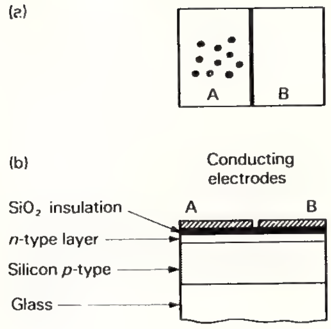

Figure 1. Elementary idea of two charge elements coupled together *via* the *n*-type channel and controlled by voltages at A and B in sequence (see text).

The first, essential point to be understood is that the doped layers are depleted for use in CCDs. That is to say, they are deprived of mobile carriers, which are electrons in the *n*-type and 'holes', or electron deficits, in the *p*-type. This is done by applying a reverse bias, or opposing potential, of about 20 V. It ensures that the *n*-type layer has plenty of space for electrons, often described as a conducting layer or channel. The depleted *p*-type layer is left negatively charged to a small depth, keeping electrons up into the channel.

The arrangement shown is not of any practical use, for alternation of the voltages on A and B would merely keep the charges going backwards and forwards between them. However, a linear arrangement of a number of elements could be useful if we can have a way of getting the voltages on the electrodes in the correct sequence. This is done by what is called a three-phase system. If we assume a charge of electrons under A (figure 2) and that the potential φ_1 is reduced to zero while φ_2 is given a voltage, then the charge moves from A to B, φ_3 also being zero. Next, φ_2 is reduced to zero and φ_3 given a voltage, and the charge moves to C. Next, φ_3 goes to zero and φ_1 is given a voltage. The charge moves to D. So the correct sequence of voltages in time makes the charge move along, eventually reaching J, where it goes to an amplifier and so forth. Obviously, there has to be a clocked sequence of voltages in the right order. It is obvious, too, that there is never a condition where there are two or three charges contiguous.

The array so far considered is a *linear* one. It can be used in analogue mode, with each charge differing, or digital mode with individual charges representing 1 or 0. It can operate as a shift register, a serial-access store in computers, a delay line in telecommunications and television circuits and even, suitably modified, as a band-pass filter. It has been used for aerial surveillance and in other practical gear.

But what has put the CCD into the frontier of several fields of scientific research and development in the last few years is the idea of making it into a two-dimensional array, an area rather than a line. The reason lies in the fact that charges can be created in several ways. In the linear device, the first charge usually comes from preceding circuits and at exit goes into another circuit. However, when light enters silicon it creates charges by photoelectric effect, and the spectral range of sensitivity is quite wide. Also, if a high-energy particle enters an element of a CCD array it creates a charge by ionization. For these kinds of charge-creation the electrodes have to be transparent, which is arranged by making them of very highly doped silicon or of polycrystalline silicon instead of metal; they conduct well enough.

Area Array

If we imagine the linear array of figure 2 to be up-ended, with A at the top, and turned to show the electrode faces, and then add similar arrays side by side, we get the idea of an area array (except that, of course, the whole area is formed on one silicon chip). In addition, in order to restrain the electrons from moving sideways (that is, in the direction of the conventional *x*-axis in our imagined picture), so-called channel stops are formed from top to bottom after every three elements. Each stop is an extremely shallow channel and consists of very heavily doped *p*-type silicon; when depleted, it becomes a strong, negatively-

Figure 2. Linear arrangement of a CCD. Charge is moved along one element at a time from left to right. (Overlaps of electrodes are omitted for clarity.)

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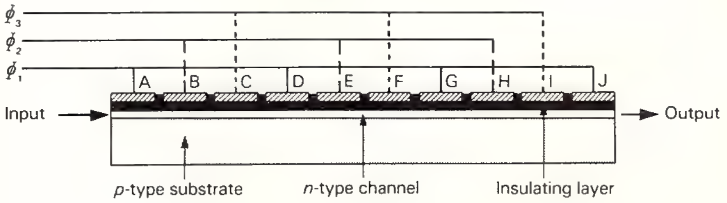

charged barrier. A picture-element, or pixel as it is known, then consists of an area covering three CCD elements horizontally and vertically. Obviously, the charges in each pixel cannot be seen. They are transferred, one row at a time, (in a so-called frame-transfer technique, which is not the only way) to a linear shift register with its own three-phase clock-pulse supply, so that each pixel charge is transferred individually into circuitry that includes micro-processors: the Cartesian co-ordinates and the size of the charge in each pixel are stored and transferred to a television screen or visual display unit (VDU), on which we can see the picture of how the original light or ionization is disposed, just as if the area CCD array were a photographic plate.

The advantage of such a CCD image sensor for astronomy has been described by one scientist for the UK Science and Engineering Research Council in quite unscientific terms: he says the sensitivity is "staggering". One sensor having 576 x 385 pixels in a surface of about 15 mm x 9 mm is in use at the Royal Observatory, Edinburgh. A CCD sensor has been commissioned for the Anglo-Australian telescope and yet another for the South African Astronomical Observatory. Stars and galaxies extremely difficult or impossible to photograph even with hours of exposure can now be recorded in minutes.

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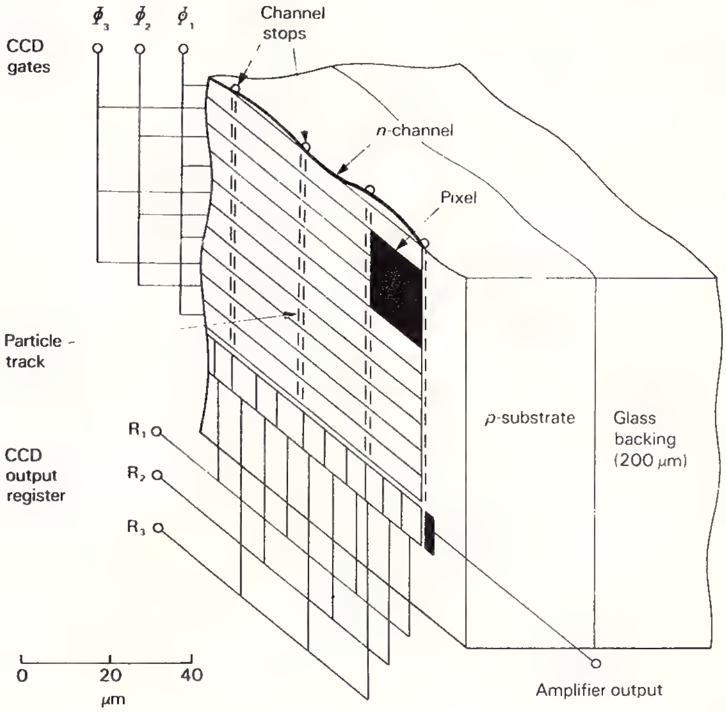

Figure 3. Area array with channel stops to restrain lateral movement of electrons. The pixel, or picture element consists of three CCD elements horizontally and vertically.

The need in high-energy physics is quite different. As everyone now knows, many particles have been identified and given strange names, with properties such as 'beauty' and 'charm'. Most of them have lifetimes expressible only with the help of large negative indices, for example 10^{-12} seconds, so measuring them and their interactions has become more and more exacting. To do the job, highly-sophisticated pieces of apparatus such as the bubble chamber have been devised. Now, with the high sensitivity and resolution of CCD image sensors, together with the easy processing of the results by computers, physicists have yet another refined tool to use.

One experiment with four sensors is shown in figure 4. An energetic particle hits a target, T. At one collision it causes the emission of particles with tracks P_1 and P_2. Then, perhaps a couple of millimetres further on, it has another collision that gives rise to particle tracks Q_1 and Q_2. Ordinarily it would be impossible to differentiate between the Ps and Qs but with a CCD technique it should be possible to measure what happens with a precision of a few micrometres.

C.L. Boltz, Spectrum 182.

Figure 4. Four CCD plates arranged to detect secondary particles from the collision at Q.

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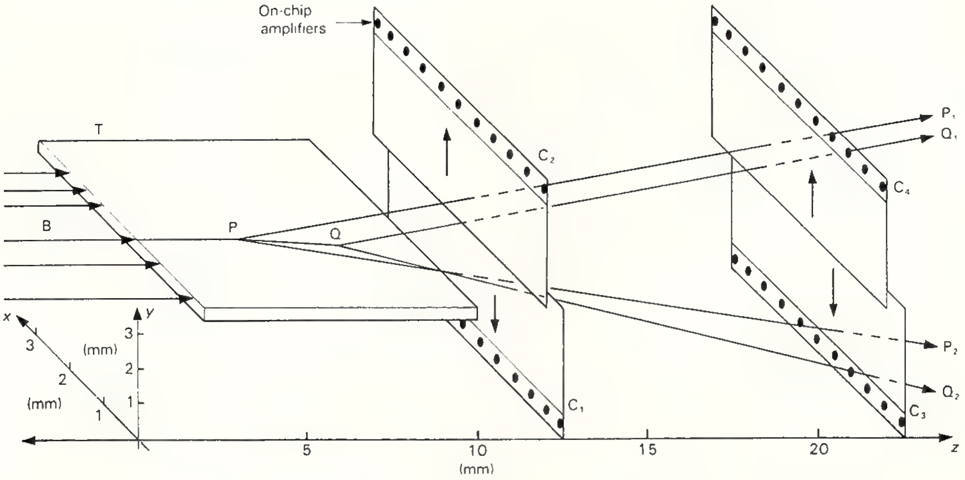

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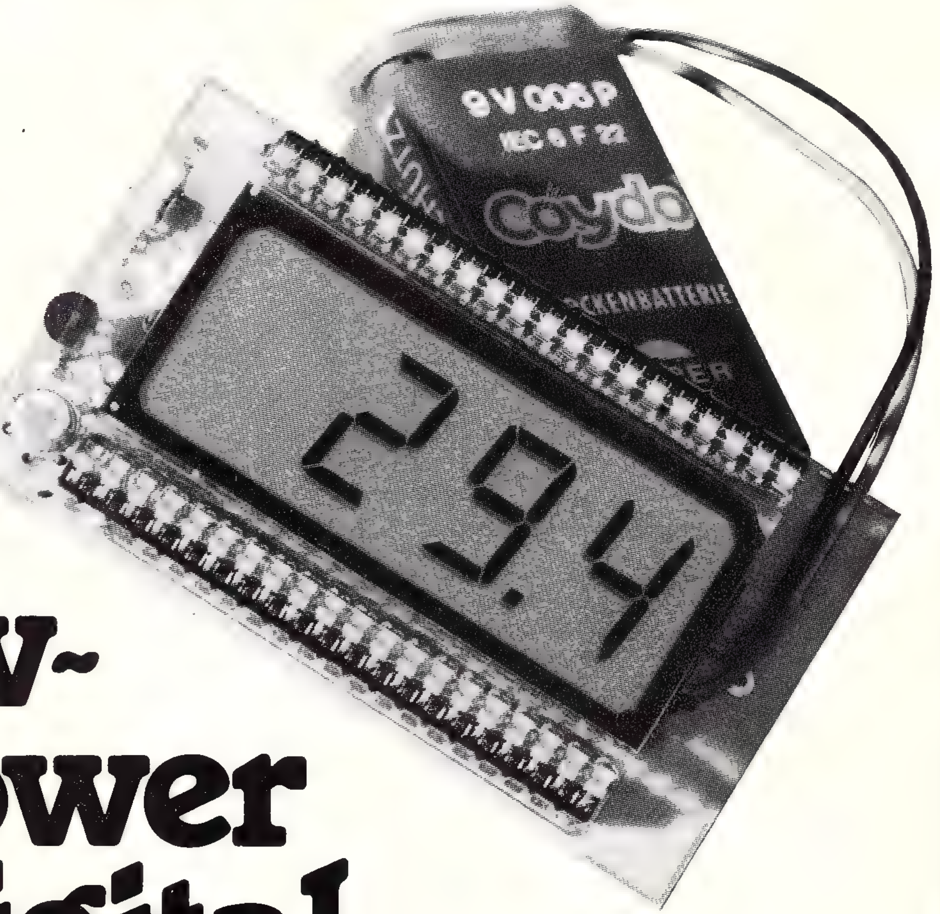

low-power digital thermometer

A large number of digital thermometers are available at present. Elektor has also kept up with the trend and published a standard digital thermometer with liquid crystal display in the October 1982 issue. Why is it that only a few months later we are coming out with a successor to the circuit already published? The thermometer described in this article can be operated continuously for more than six months without changing the battery. That is quite an achievement and already makes our last thermometer circuit appear a little obsolete!

continuous operation for more than 6 months

In spite of the wide choice of devices available, digital thermometers have not yet become fully accepted. The advantages are: the temperature can be clearly read off at a distance; the response time is very short and the temperature sensor can be installed at some distance from the unit.
In contrast to the usual mercury and 'pointer' thermometers, however, the electronic version requires its own power source. Of course, it is also much more expensive. It seems, therefore, that digital thermometers will only become more popular when the problem involving price and energy consumption has been at least partially solved. Special ICs are needed for this type of circuit, but the investment is worthwhile.

The circuit

In principle, this thermometer consists of two main circuit components (see figure 1). These are the temperature sensor IC2, whose output voltage is proportional to the temperature, and the analogue-to-digital converter IC1, which converts this voltage value to the corresponding binary number and also has the task of driving the liquid crystal display.
The analogue-to-digital converter ICL 7136 (IC1) is a chip with an extremely low current consumption, approximately 50 μA, which operates according to the dual-slope principle. With a reference voltage of 100 mV which must be applied to it

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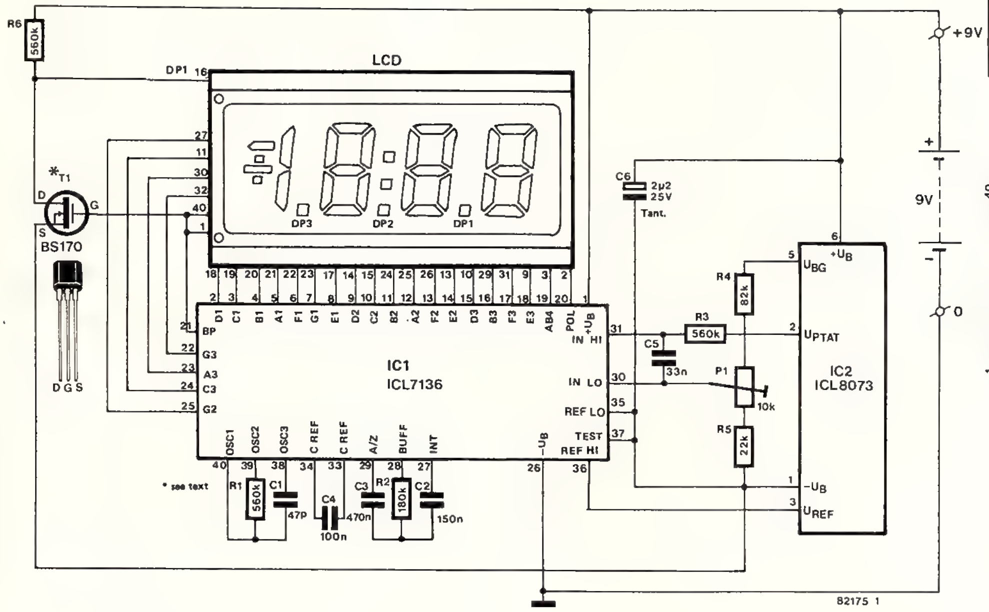

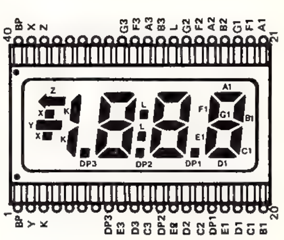

Figure 1. The circuit of the low-power digital thermometer mainly consists of two special ICs and the liquid crystal display. IC2 operates as a temperature sensor. IC1 evaluates the voltages of IC2 and drives the LCD. The operating current drawn by the entire circuit does not exceed 150 μA.

between REF_{LO} and REF_{HI}, its measuring range is then ± 199.9 mV.
Thus the converter directly indicates with proper polarity the voltage applied to its inputs IN_{LO} and IN_{HI}. The sign is positive if the potential applied to IN_{HI} is higher than that at IN_{LO}; in the inverse case, a "–" appears on the display. The frequency of the internal oscillator is adjusted with external components C1 and R1. At the specified values, a clock frequency of approximately 16 kHz is obtained; this means that the ICL 7136 executes approximately one conversion per second. Polycarbonate or polyester capacitors should be chosen for C1, C3 and C4 to keep the measuring error of the A/D converter less than 0.1°C (0.1°C corresponds to 1 LSB). The backplane signal must be inverted to generate the decimal point. This is performed with transistor T1 and resistor R6. An alternative is to utilise a BC 549C with a 4M7 base resistor.

The temperature sensor ICL 8073 (IC2) operates with a supply voltage of approximately 5 V which is presented to it by the A/D converter at the $+U_B$ and TEST terminals. The 100 mV reference voltage for the A/D converter is presented by the sensor between U_{REF} and $-U_B$. The 1 mV/K voltage which is proportional to the temperature (with respect to $-U_B$) is generated at U_{PTAT}. This signal is applied to the measuring input of the A/D converter via a lowpass network consisting of R3 and C5. At 0°C (corresponding to 273 K), therefore, an output voltage of 273 mV is present. As already mentioned, the difference voltage between IN_{HI} and IN_{LO} is indicated by the A/D converter. Thus a voltage of 273 mV must be presented to the IN_{LO} input in order for the LCD to display the value '0' at 0°C. This is achieved by dividing down the reference voltage U_{BG} (approximately 1.23 V) via potential divider R4, P1, R5 and

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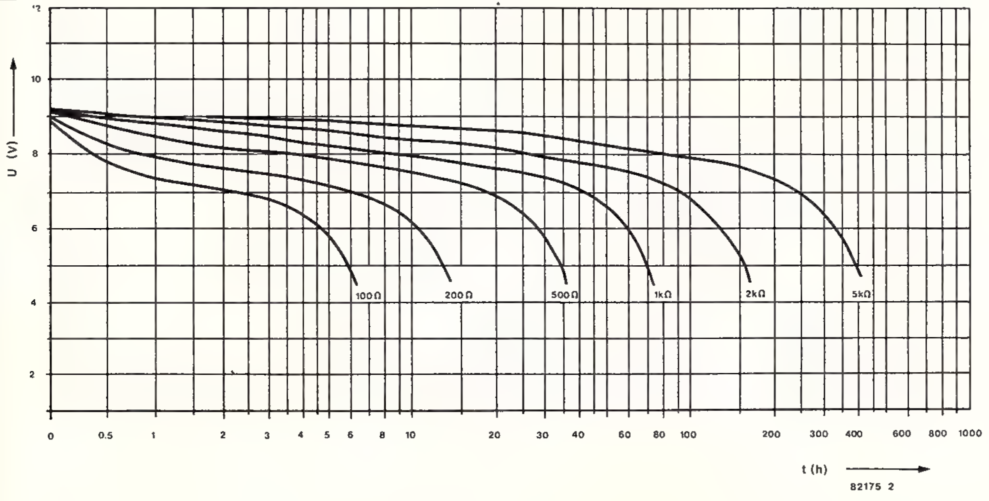


Figure 2. Typical characteristics of a 9 V alkali-manganese battery. With a minimum battery voltage of 6.2 V and average load resistance of 75 kΩ, the operating time obtained is approximately 5400 hours!

by adjusting preset potentiometer P1 to obtain exactly 273 mV at IN_{LO}. The temperature sensor ICL 8073 draws a current of approximately 50 μA.

Energy consumption

A typical current consumption of 120 μA can be expected for the entire circuit. To calculate the life of a 9 V battery, the data sheet of the VARTA 4022 alkali-manganese battery was taken as a basis; this includes the typical discharge characteristics under continuous load using resistances of 100 Ω . . . 5 kΩ. These curves are shown in figure 2. The entire thermometer circuit operates quite happily with supply voltages of 12 V to approximately 6.2 V. Taking 6.2 V as the lower limit of battery voltage and an average load resistance of 75 kΩ, the group of curves can be extrapolated to obtain an operating time of approximately 5400 hours. This corresponds to continuous operation for more than 7 months. It is quite possible, however, that longer or shorter operating times will be achieved because the calculations relate to typical data for the discharge characteristic and current consumption of the temperature sensor and of the A/D converter. In general though, the typical data are met by approximately 50% of the components.

Precision

Linearity of the thermometer depends almost exclusively on the temperature sensor, because the specifications of the ICL7136 A/D converter are so good that its error contribution can be discounted. The ICL8073 temperature sensor can be procured in different classes of precision and specified temperature ranges. Its transfer characteristic has the form shown in figure 3a. The thermometer can be aligned at any temperature with preset potentiometer P1. The slope of the characteristic is needed to be able to calculate the measuring error in the region of this alignment point. In this case it is practical to replace the curve by a straight line as an approximation, as shown in figure 3a. After the 25°C alignment the ideal characteristic is shifted as shown in figure 3b. If one calculates the error of the lowcost ICL8073 JIUT sensor, whose specified maximum linearity error is ±1.5°C over the temperature range 0 . . . 70°C, the resultant maximum error is ±0.2°C over a range of ±5°C around the alignment point. The highgrade ICL8073 KIUT sensor would have a maximum error of ±0.026°C under the same conditions. A slight, additional measuring error is caused by the tolerance of the reference voltage presented to the A/D

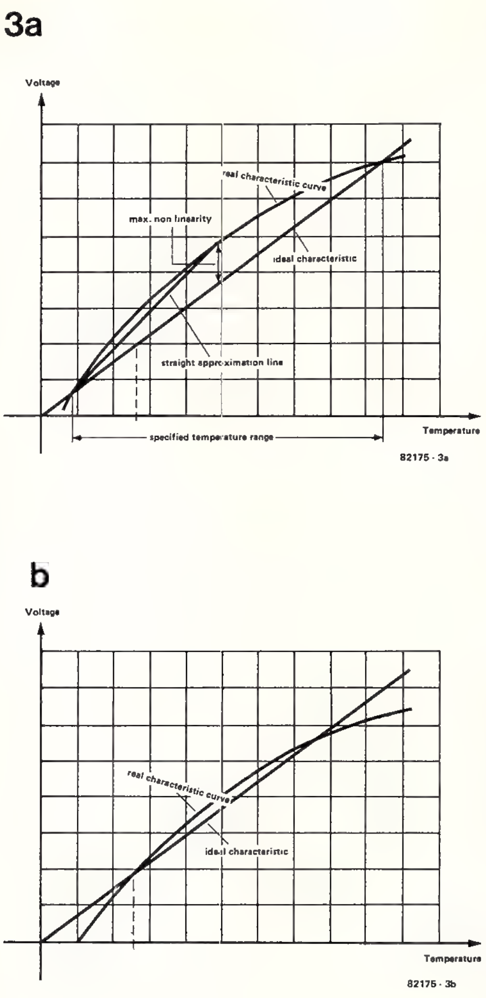
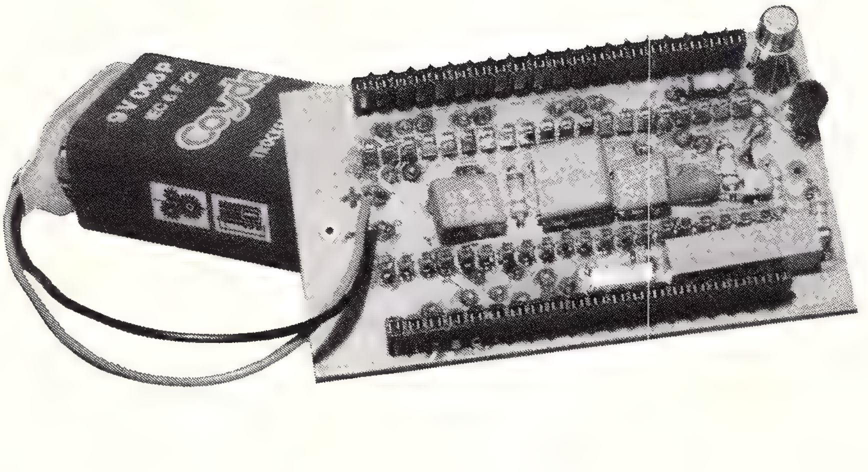
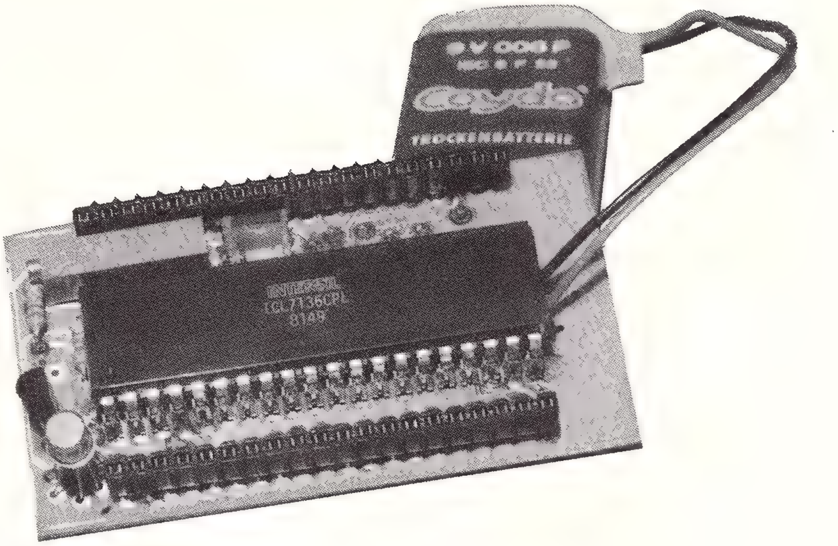


Figure 3. The linearity error of the thermometer in the region of room temperature is best indicated by these characteristics. If, for example, alignment was performed at 25°C the resultant maximum error is ±0.2°C over a range of ±5°C around the alignment point (figure 3b). Figure 3a shows the real and ideal characteristics for the specified operating range. In the region of the alignment point, the characteristic curve is approximated by a straight line.



Components are mounted on the board in three layers. The capacitors and resistors form the first layer . . .



. . . and IC1 is mounted above them, as the second layer (using IC contact strips). The third layer is the LCD display, producing the final result on the first page of this article.

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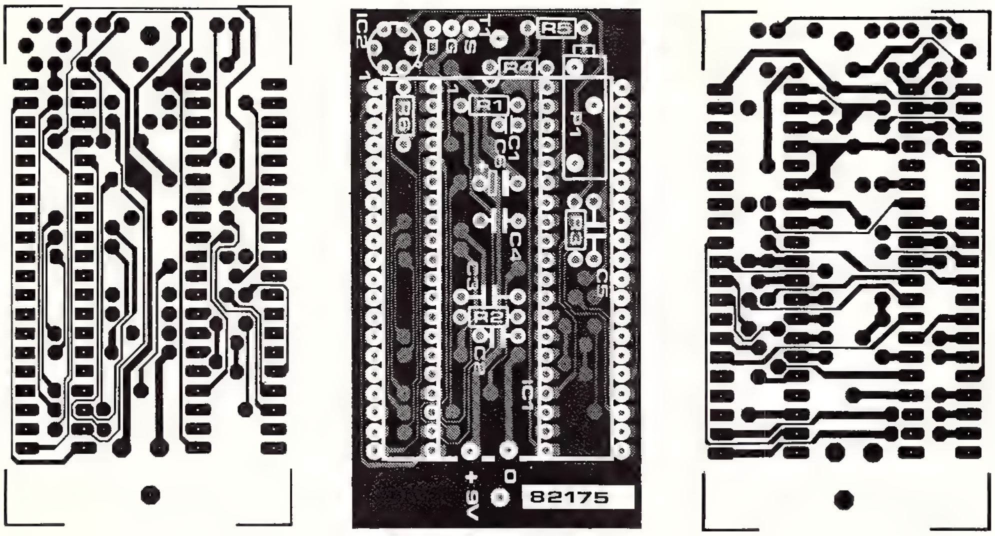

Figure 4. Track pattern and component overlay of the dual-clad, through-contacting thermometer p.c.b.. It is constructed in three levels. Care should be taken to produce a strong mechanical construction. As an option, the sensor can be directly inserted into the p.c.b..

converter by the sensor; its value should be exactly 100 mV. However, this error is mainly noticeable at the limits of the measuring range and is negligible in ambient temperature measurements.

Construction and alignment

Construction of the digital thermometer using the printed circuit board of figure 4 requires some care. The thermometer is constructed in three levels. Fit all passive components first. The capacitors within the socket for IC1 (IC contact strips) must be bent over to prevent them from protruding beyond the contacts. Incidentally, these capacitors must be fully encapsulated in plastic to prevent short-circuits.

The contacts used for the liquid crystal display can be of the same type as those for IC1. It is better, however, to use the more solid, plastic-base type.

The temperature sensor IC2 can be directly inserted into the p.c.b. or solder pins can be inserted in its place, to allow its connecting leads to be soldered on later.

IC1 forms the second level of the thermometer module. The liquid crystal display is mounted on it in piggyback fashion. Care should be taken to produce a strong mechanical design, i.e. so that IC1 and the display are firmly seated in their sockets.

Since the thermometer is particularly suitable for measuring room temperature, on account of the sensor used, the 'comparison method' is utilised for simple alignment. In the Elektor laboratory a standard alcohol thermometer was used as a reference. P1 is adjusted to obtain its value on the LCD. An occasional comparison between the two readings indicates whether the low-power digital thermometer is accurate. It may be necessary to readjust P1. Incidentally, there is no on/off switch in our circuit. With a current consumption of 150 μA such a switch seemed an unnecessary luxury! ◾

Parts list

Resistors (1/8 W):
R1,R3,R6 = 560 k
R2 = 180 k
R4 = 82 k
R5 = 22 k
P1 = 10 k preset (multiturn)

Capacitors (see text):
C1 = 47 p
C2 = 150 n
C3 = 470 n
C4 = 100 n
C5 = 33 n
C6 = 2μ2/25 V tantalum

Semiconductors:
T1 = BS 170 or BC 549C (see circuit description)
IC1 = ICL 7136 (Intersil)
IC2 = ICL 8073 JIUT (Intersil)

Miscellaneous:
9 V compact battery with terminals and leads
3½-digit liquid crystal display:
Hitachi LS 007CC,
H 1331C-C
LXD 43D5R03
Hamlin 3901, 3902
Norsem NDP
530-035A S-RF-P1

The phono preamp is an important part of the Prelude, or indeed of any audio system. Gramophone records are still the recording medium that offers the highest quality, provided a good cartridge and preamp are used. Most of the really good cartridges are the moving coil type, and these require a step-up transformer or, as is more common nowadays, a so-called pre-preamp.
The phono preamp and the moving coil pre-preamp described in this article are designed to form a single module. This can be incorporated in any audio system, although it is intended as part of the Prelude.

MC/MM phono preamp

100 μV in, 100 mV out

Photo. The complete MC/MM phono preamp module. Once all the connecting wires are in position, it is a fairly rigid construction.

A phono preamp must do two jobs. It must boost the output from a moving magnet (or 'dynamic') cartridge to a sufficient level, and it must modify the frequency characteristic in a precisely-defined way. Figure 1 shows the theoretical recording characteristic as a set of bold straight lines, running from lower left to upper right; the thin line running through these is the actual characteristic. To achieve a flat overall response, the inverse characteristic must be applied during playback; this is the thin line running from upper left to lower right in figure 1.
Achieving this type of characteristic may seem quite a feat, but in fact it is mainly a question of ensuring that a set of normalised RC time constants are included in the preamp. For once, the Americans agree with us: their RIAA response corresponds to the European IEC specification. Reading from left to right in figure 1, the first time constant is 3180 μs: this causes the response to fall at 6 dB/octave from about 50 Hz. Then we come to 318 μs – this tends to flatten out the response above 500 Hz – almost immediately followed by 75 μs, which leads to a further 6 dB/octave slope above 2120 Hz.
Knowing what time constants are required is one thing; knowing where to insert them in the circuit is another. There are two basic possibilities: you can either use passive RC networks, or you can include them in a feedback loop to obtain active filters. Obviously, since there are three time constants to be included, you can also include one or two as passive networks and the rest as an active network. Some of the possi-

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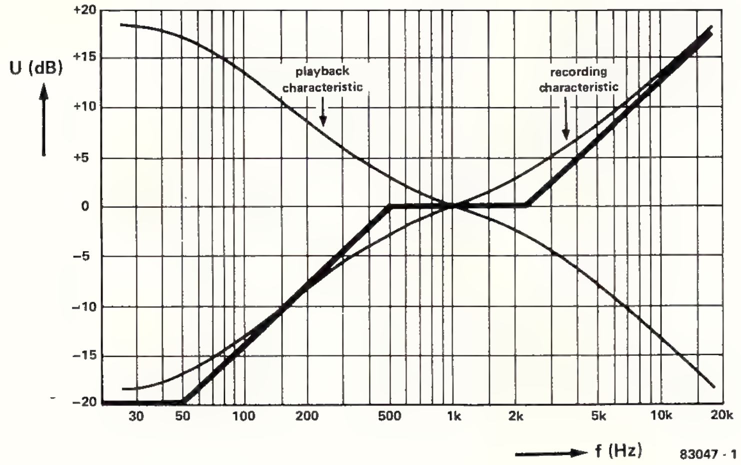

Figure 1. The frequency characteristic used when cutting a record (lower left to upper right), and the response required during reproduction (upper left to lower right).

bilities are illustrated in figure 2.

A passive filter can be mounted at the preamp input, as shown in figure 2a. This has the disadvantage that the signal level is drastically reduced at high frequencies (−30 dB or so!) before it reaches the input stage. This is asking for a poor signal-to-noise ratio.

So, try it the other way: mount the RC networks at the output, as shown in figure 2b. Now we run into a new problem: the input signal is at such a level that it will not only mask the noise, but there is a good chance that it will drive the preamp into distortion!

The most common approach is shown in figure 2c. The RC networks are included in the feedback loop. Provided the circuit is properly designed, this can give quite good results. However, the system shown in figure 2d is even better: the two lower time constants are included in the feedback loop, so that there is little risk of overloading the preamp. The third RC network, however, is included as a passive filter at the output. This means that the higher frequencies are passed through the preamp at relatively higher levels, thus improving the overall signal-to-noise ratio. As an added bonus, this system makes it slightly easier to design a good preamp: rolling off the frequency response of an amplifier towards higher frequencies tends to lead to instability!

Reading between the lines in the last paragraph, it will be obvious that the circuit described here corresponds to figure 2d.

The moving-magnet preamp

The right-hand section of figure 3 should by now be familiar: basically, it is the 'discrete opamp' that is used throughout the Prelude. The circuit was discussed at length in the articles on the headphone amplifier and the line amplifier, so there is little point in repeating the whole story here.

In a nutshell: the input stage is a differential amplifier (T1, T2) with a current source in the commoned emitter line (T3). The collector output currents are combined by

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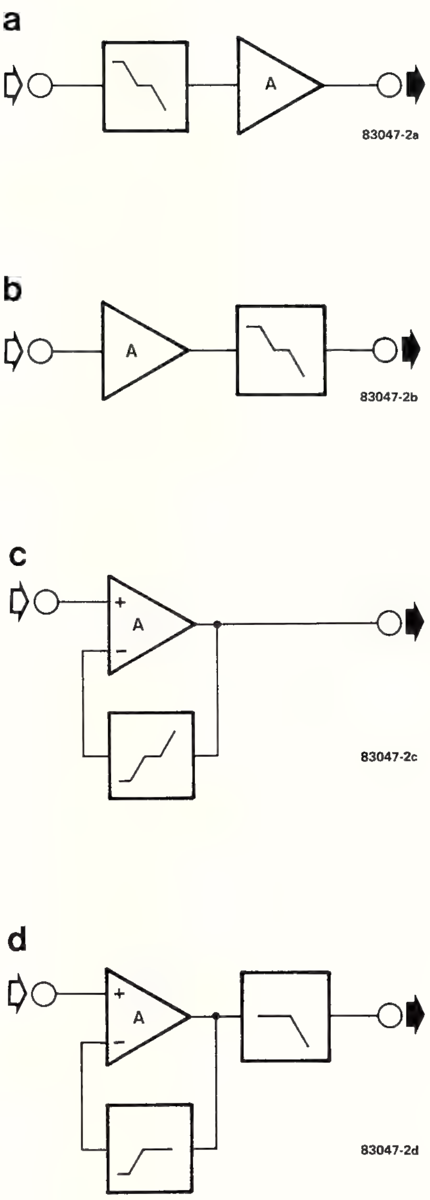

Figure 2. The official time constants can be included in the preamp in several ways. Purely passive networks can be used, either preceding (2a) or following (2b) the preamp; or the networks can be included in the feedback loop (2c). The solution shown in figure 2d (two time constants in the feedback loop and one as a passive network at the output) gets the best of both worlds.

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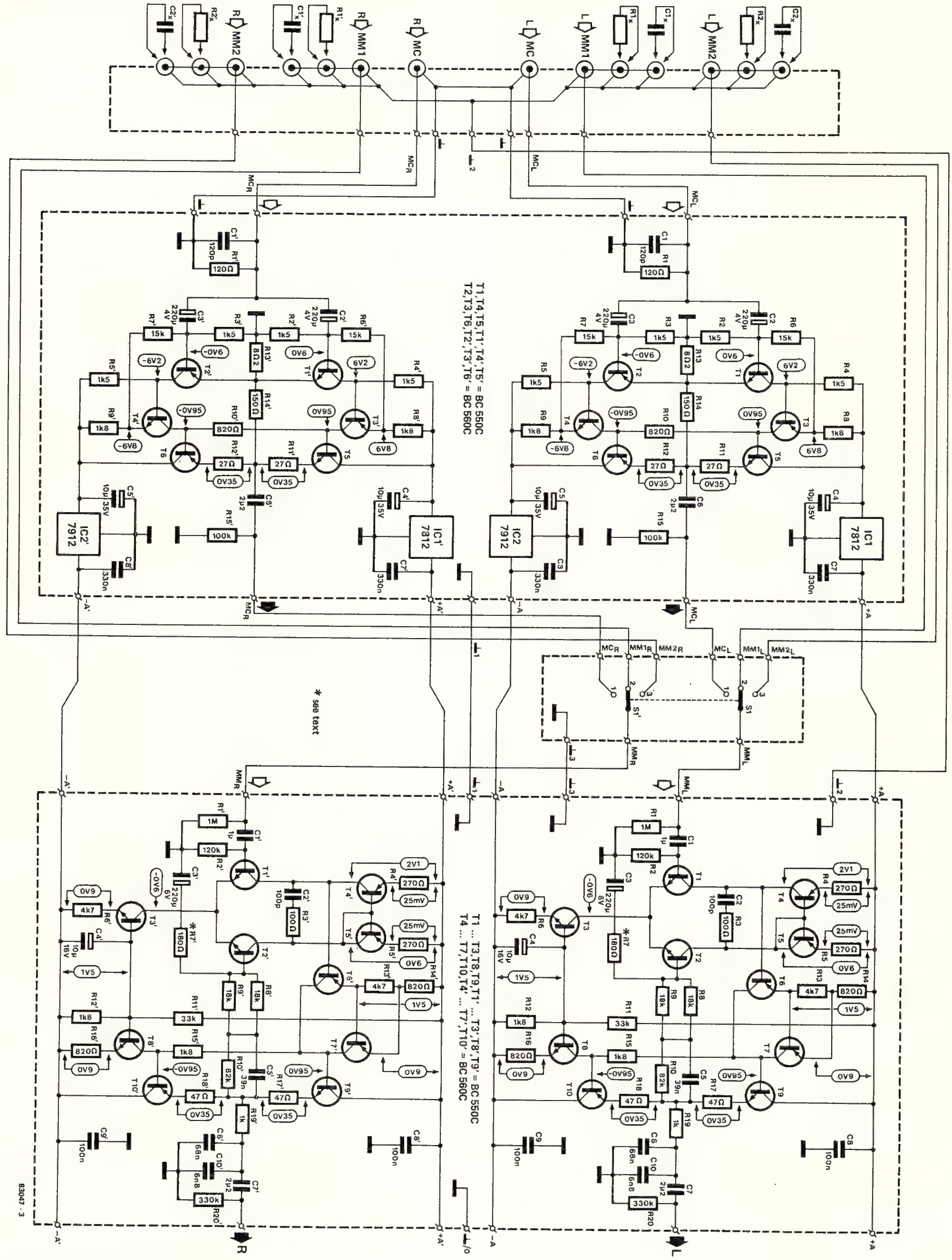

Figure 3. The complete circuit, with moving coil pre-preamp and moving magnet preamp. Additional input sockets are provided, so that the input impedance can be tailored to suit any particular cartridge.

Parts list for MC pre-preamp

Resistors:
R1,R1' = 120 Ω
R2 . . . R5,
R2' . . . R5' = 1k5
R6,R6',R7,R7' = 15 k
R8,R8',R9,R9' = 1k8
R10,R10' = 820 Ω
R11,R11',R12,
R12' = 27 Ω
R13,R13' = 8Ω2
R14,R14' = 150 Ω
R15,R15' = 100 k

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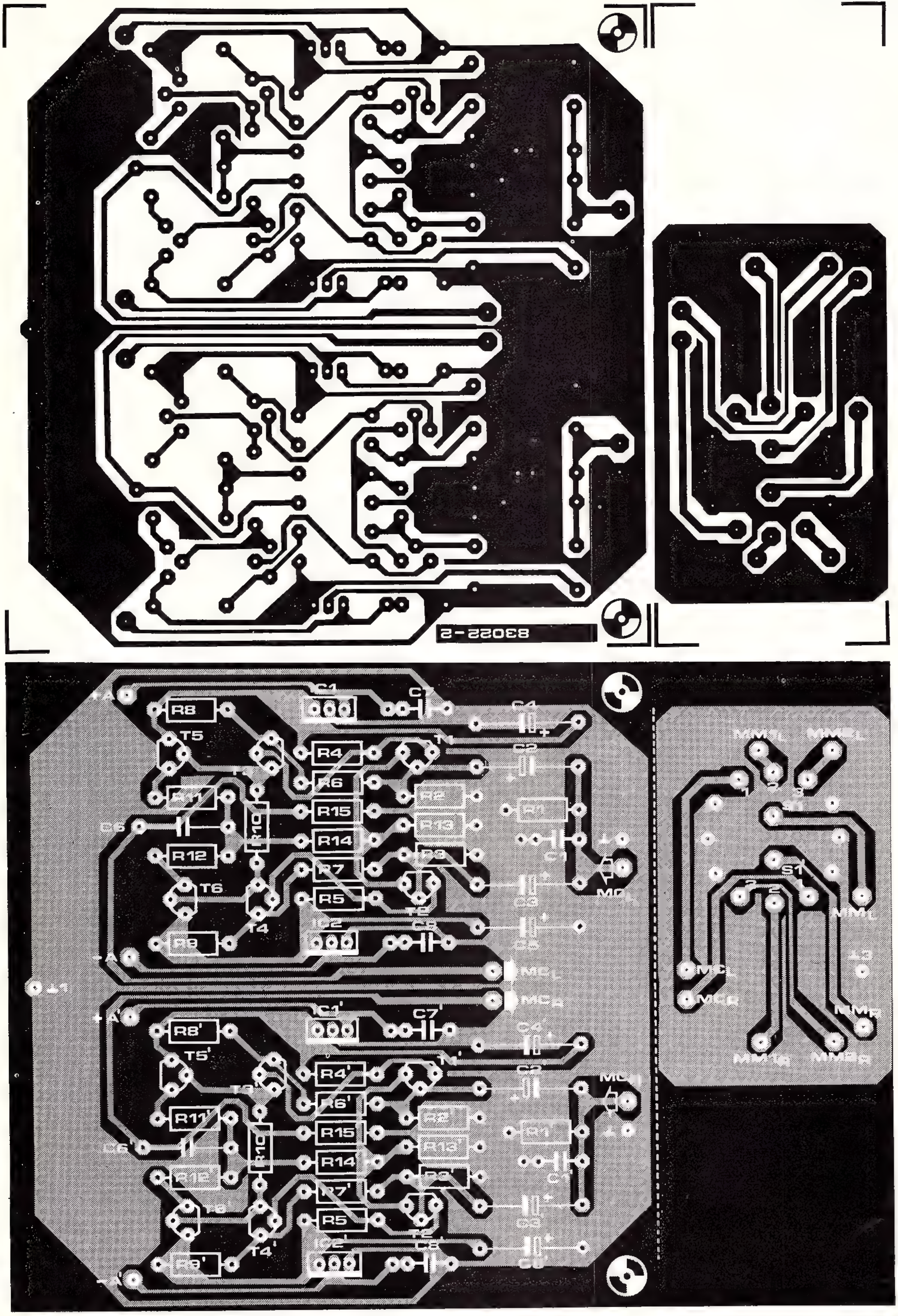


Figure 4. This board actually consists of two parts that must be separated. The larger section is for the moving coil pre-preamp; the smaller piece is for mounting the input selector switch.

Capacitors:
C1,C1′ = 120 p
C2,C2′,C3,C3′ = 220 µ/4 V
C4,C4′,C5,C5′ = 10 µ/35 V
C6,C6′ = 2µ2
C7,C7′,C8,C8′ = 330 n

Semiconductors:
T1,T1′,T4,T4′,T5, T5′ = BC 550C
T2,T2′,T3,T3′,T6, T6′ = BC 560C
IC1,IC1′ = 7812 (5%)
IC2,IC2′ = 7912 (5%)

Miscellaneous:
S1 = 2-pole, 3-way p.c.-board mounting rotary switch
extension spindle for S1, with front-panel mounting bearing

5

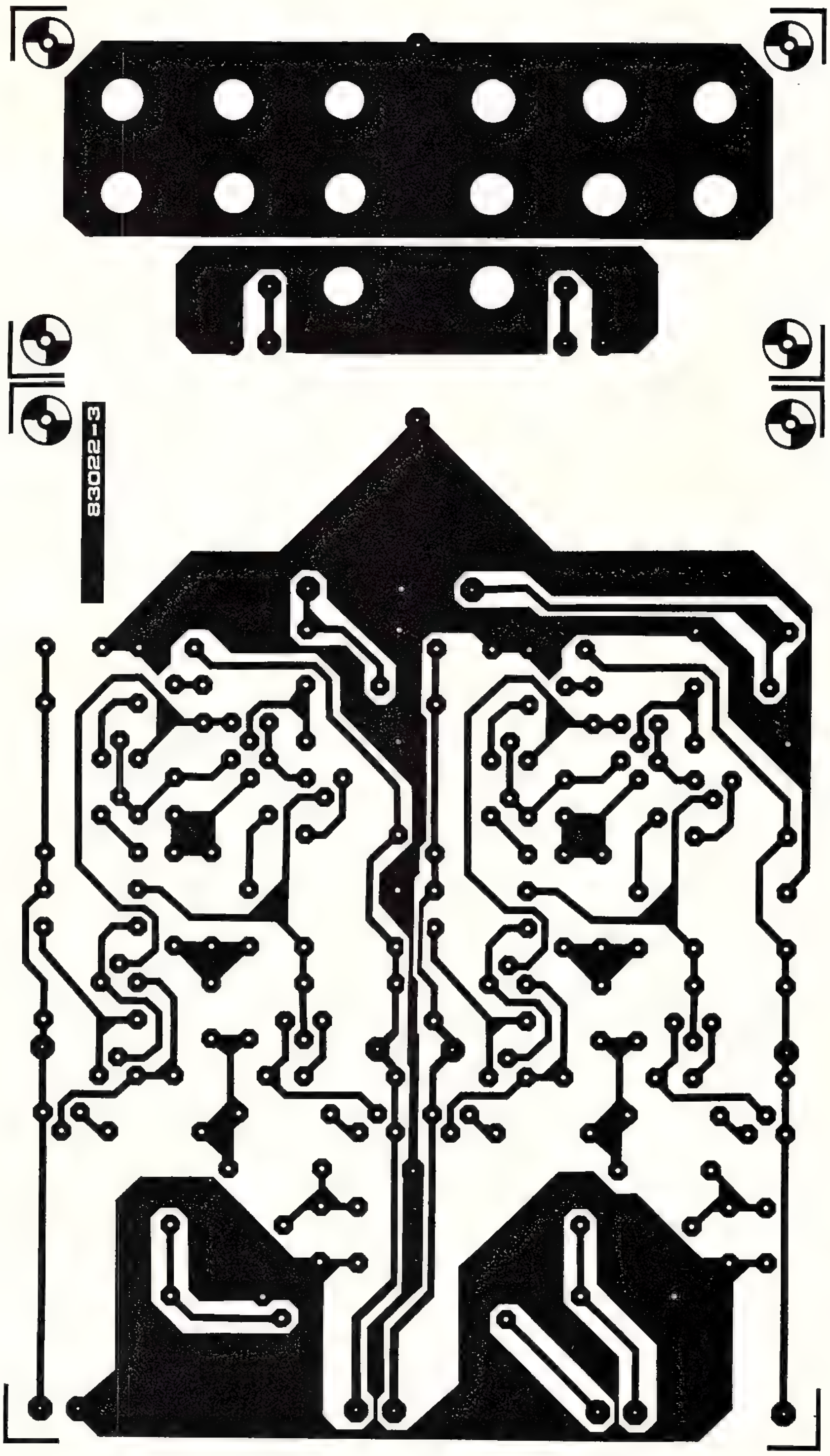
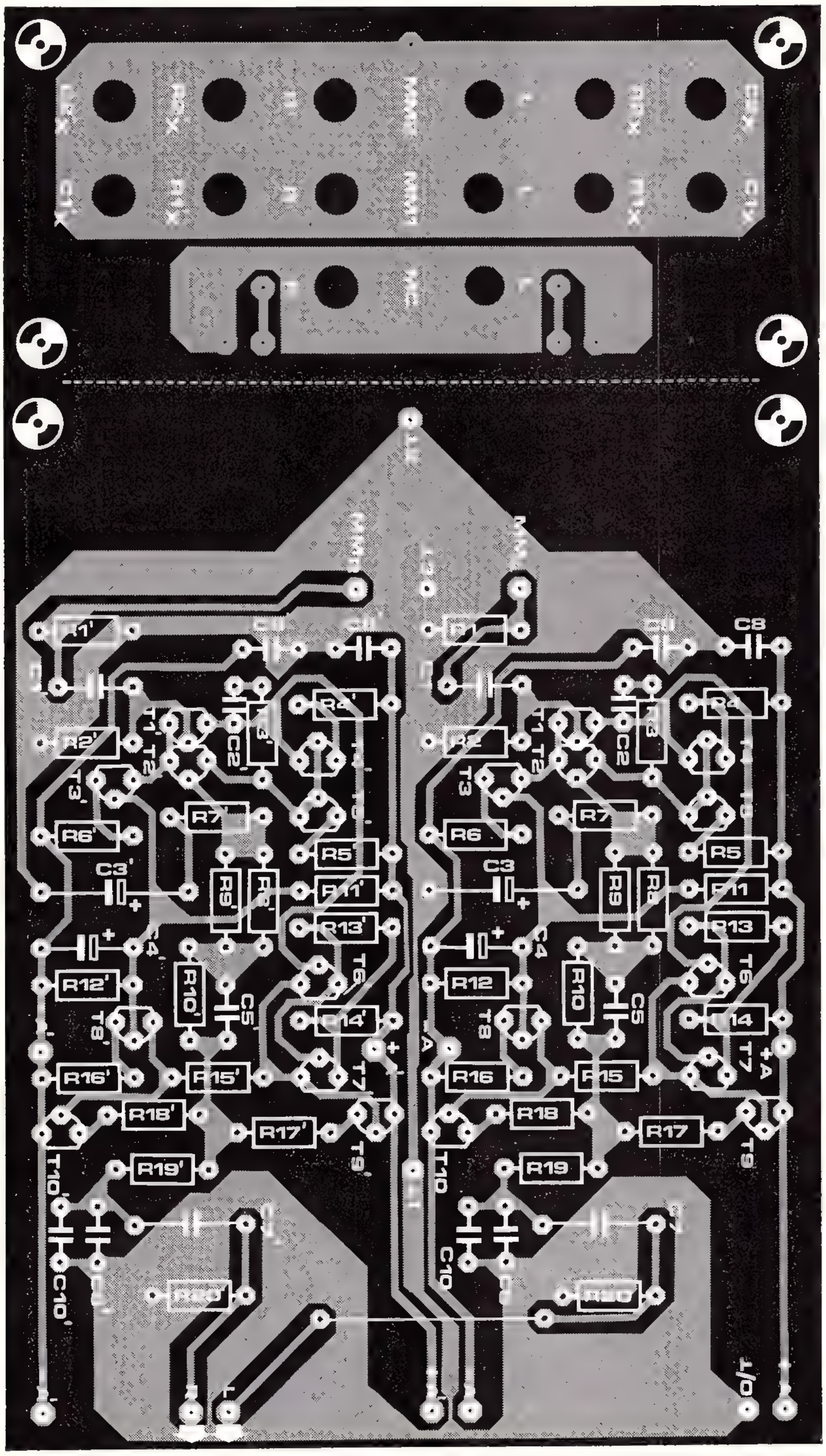


Figure 5. The p.c. board for the moving magnet preamp and that for the cinch input sockets. These boards must be separated before mounting any components.

means of a current mirror (T4, T5) and passed via a Darlington stage (T6, T7) with a current source as collector load impedance (T8) to the class-A output stage (T9, T10). The feedback loop (C5, R7 . . . R10 and C3) includes the first two time constants, as explained above. This means that the response is flat above about 500 Hz, with a gain of 50 set by the ratio of R8//R9 to R7. From 500 Hz down to 50 Hz, the response rises at 6 dB/octave; below 50 Hz, the gain is again constant (500, set by the ratio of



Parts list MM preamp

Resistors:

R1,R1' = 1 M
R2,R2' = 120 k
R3,R3' = 100 Ω
R4,R4',R5,R5' = 270 Ω
R6,R6',R13,R13' = 4k7
R7,R7' = 180 Ω
R8,R8',R9,R9' = 18 k
R10,R10' = 82 k
R11,R11' = 33 k
R12,R12',R15,R15' = 1k8
R14,R14',R16,
R16' = 820 Ω
R17,R17',R18,
R18' = 47 Ω
R19,R19' = 1 k
R20,R20' = 330 k
$R1_x$,$R1_x'$,$R2_x$,
$R2_x'$ = see text

Capacitors:

C1,C1' = 1 μ
C2,C2' = 100 p
C3,C3' = 220 μ/6 V
C4,C4' = 10 μ/16 V
C5,C5' = 39 n
C6,C6' = 68 n
C7,C7' = 2μ2
C8,C8',C9,C9' = 100 n
C10,C10' = 6n8
$C1_x$,$C1_x'$,$C2_x$,
$C2_x'$ = see text

Semiconductors:

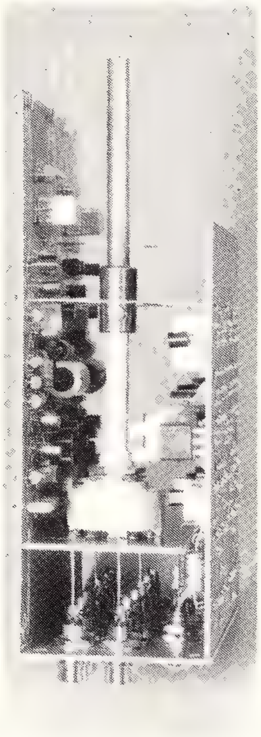
T1,T1',T2,T2',T3,T3',
T8,T8',T9,T9' = BC550C
T4,T4',T5,T5',T6,T6',T7,
T7',T10,T10' = BC560C

Miscellaneous:

14 metal cinch sockets,
screw-mounting
8 cinch plugs for
R_x and C_x

R8//R9 + R10 to R7). The third time constant, causing the response to roll off above 2120 Hz, is the passive output network (R19, C6 and C10).
There are three inputs, selected by means of S1: the moving coil pre-amp and two moving magnet inputs. These are shown at the left in figure 3. There are actually three sockets for each of these inputs: one for the signal input, and two for impedance matching (R_x and C_x). This is explained in detail in a separate article ('RC equalizer'), elsewhere

in this issue. Note that the basic input impedance of the preamp is 107 k (R1//R2), so that four 82 k resistors must be inserted in the R_X positions to obtain the 'standard' 47 k input impedance.



The moving-coil preamp

Moving coil cartridges give a beautifully 'clean' signal, but at a very low level (100 . . . 500 μV). This means that a 'pre-preamp' must be included between the cartridge and the 'normal' moving magnet preamp.

The pre-preamp is the left-hand section in figure 3. It is a fairly simple-looking circuit, but it is designed for extremely high performance – in particular, the signal-to-noise ratio must be exceptional in this application. A fully-complementary class-A design is used. T1 . . . T4 give high gain, and T5 and T6 are the output drivers. The gain is set by R14 and R13 in the feedback loop; very low values are used to obtain an extremely low input noise figure. The gain of this pre-preamp is 20; overall, from MC input to phono preamp output, this means that the gain is 1000. In other words, 100 μV in will give 100 mV out.

The DC setting is determined by R2, R3, R6 and R7; the current through the input devices is determined by R4 and R5. This means that anyone who feels like experimenting with different input transistors can easily set the optimum collector current by modifying these two resistors.

The positive and negative supplies are derived from the main +15 and –15 V rails. Integrated 12 V regulators are included, mainly to ensure that no hum, noise, interference spikes or whatever can possibly reach the pre-preamp.

The input impedance is approximately 100 Ω: suitable for practically all moving coil cartridges. If an even lower impedance is desired, the value of R1 (and R1') should be reduced accordingly.

Construction

Although the moving-magnet preamp and the moving-coil pre-preamp are both complete units that can be used separately, we will only discuss the construction of the complete phono input module – using both, in other words. Even if the pre-preamp is not (yet) needed, it is best to use both boards to obtain a reliable electrical and mechanical construction. No components need be mounted on the second board in that case.

As can be seen in figures 4 and 5, both boards consist of two sections. Before doing anything else, these must be separated. The small piece from the moving-magnet board is intended for cinch-type input sockets; the piece that is cut off the other board is used to mount the input selector switch.

As usual, good quality components should be used; R7 . . . R10, C5 and C6 should be 5% types or better. When all four boards are complete, the one with the input sockets is mounted at right-angles at one end of the moving-coil board (on the component side near the electrolytics) with the connections MCL, ⊥, MCR and ⊥ mating correctly. These four connections run from the track side of the cinch board to the component side of the moving-coil board.

The next step is to mount a set of connection wires. The four sets of three cinch plugs must be interconnected, if this was not done earlier, and a longish lead is soldered to the ⊥ connection on the free edge of the cinch board (on the track side). Four wires (4 or 5 cm long) are soldered to connections MM1L, MM1R, MM2L and MM2R on the selector switch board, again leading back from the copper track side. Two shorter sections (2 cm or so) are connected to MCL and MCR on one long edge of this board, and another pair to points MML and MMR on the opposite edge.

Having done all this groundwork, it is a good idea to compare all the bits with the photo of our prototype. When the MCL and MCR leads from the selector switch board are mated to the corresponding points on the moving-coil board, the four long leads from the switch board should reach easily to the cinch connectors. Note that the indications near the leads correspond to the four sockets that they must connect to. These leads can now be shortened to length and soldered to the sockets. Next, the moving-magnet board can be mounted (component side facing in); this involves two leads from the selector switch board and one from the input sockets. Finally, five interconnections are made between the two preamp boards – note that they all run straight across.

The completed module can now be mounted on the Prelude bus board. Unless you are very lucky, the switch shaft will have to be extended. If the rest of the modules are also in position, including the tone control unit described this month, you can proceed to the first test. With either of the MM inputs selected, no noise should be audible; for the MC input, a faint hiss may be audible with the volume control turned fully up. Not to worry: you'll have to turn the volume down again before putting on a record!

Input impedance matching

To get the best out of a dynamic (moving magnet) cartridge, the input impedance of the preamp must be properly matched. This is dealt with in greater detail elsewhere in this issue, but a few points are worth noting.

The input impedance of this preamp is approximately 107 k, parallel to 25 pF. As a first approximation, as mentioned earlier, four 82 k resistors can be mounted in the Rx sockets. This brings the impedance down to 47 k. In practice, most cartridges tend to give best results when loaded with approximately 300 . . . 500 pF; bearing in mind that the cable capacitance can be anything from 50 pF up to a few hundred pF, it is worth experimenting with several values for C_X (from zero up to about 470 p), to see which gives the best results.

So much for the analogue section of the Prelude. All that remains for the next few issues are some final comments, practical tips, and the remote control unit.

technical answers

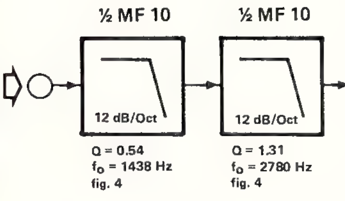
National filter with application fault

We are grateful to an observant reader for pointing out that the 'Applikator' in the September 1982 issue, concerning the National Semiconductor MF 10 filter module, contains a pretty silly mistake.

In figure 6, a Butterworth 4th order lowpass filter with a cutoff frequency of 2 kHz was assembled by connecting two 2nd order filters in series; each of these two filters also had a cutoff frequency of 2 kHz.

Of course, that simply will not work!

When connecting filters in series, both the Q and the cutoff frequency of each individual filter must be determined, in accordance with the filter type. The correct filter data are specified in the figure.



83004-2

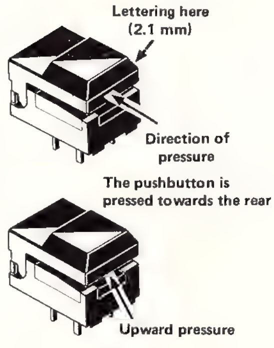
The result is that the simple circuit of figure 7 cannot be used. In order to achieve different cutoff frequencies for the two filter sections, at least one of them must be constructed according to figure 4; here the cutoff frequency not only depends on the clock frequency but also on the ratio R2:R4. Another possibility is to apply two different clock signals (corresponding to the desired filter cutoff frequencies) to the two clock inputs CLK_A and CLK_B in the circuit of figure 7.

Marking of digitast switches

Here is a tip from a reader:

If the tops of digitast switches are marked with transfer letters, the lettering soon wears off because of repeated finger pressure. However, these switches have an inclined surface at the front of the moving upper part. If this inclined surface is marked (character height 2.1 mm) the lettering is not subjected to wear.

In order to mark the fronts of digitast switches that have already been soldered in, there are two possibilities: the switch must either be unsoldered or the moving upper part must be separated from the lower soldered part of the digitast switch. The second possibility can be implemented quite simply by pressing the upper half of the switch first backwards and then gently upwards. The upper part then jumps out. To insert it again, only a slight pressure from above is required to engage the upper part once more.



83004-3

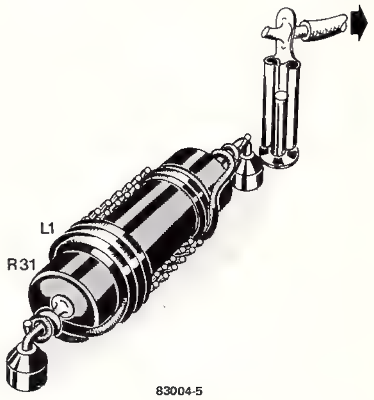
Slave flashgun powered by the mains

There is a requirement for a slave flashgun for taking a series of pictures indoors without the inconvenience of rechargeable or disposable batteries. Powering the unit from the mains would enable it to be used at any time. But why follow the usual procedure of mains voltage — low voltage — high voltage? A reader points out that it should be possible to use the mains directly without a transformer. Of course he is right. The only problem is that particular attention must be paid to electrical safety because of the lack of isolation from the mains. It did not take long to design the circuit. We have not yet tested it, but the circuit has been assembled from well-proven circuitry including the "Slave flash trigger" described in the 1982 Summer Circuits issue. The flash tube and ignition transformer are available by mail order and from some electronic component shops. The sensitivity greatly depends on the size of solar cells SZ1 and SZ2. When switch S1 is closed the flash energy is doubled. The 100 ohm resistor in the lead limits the charging current to values which are suitable for electrolytic capacitors and the mains.

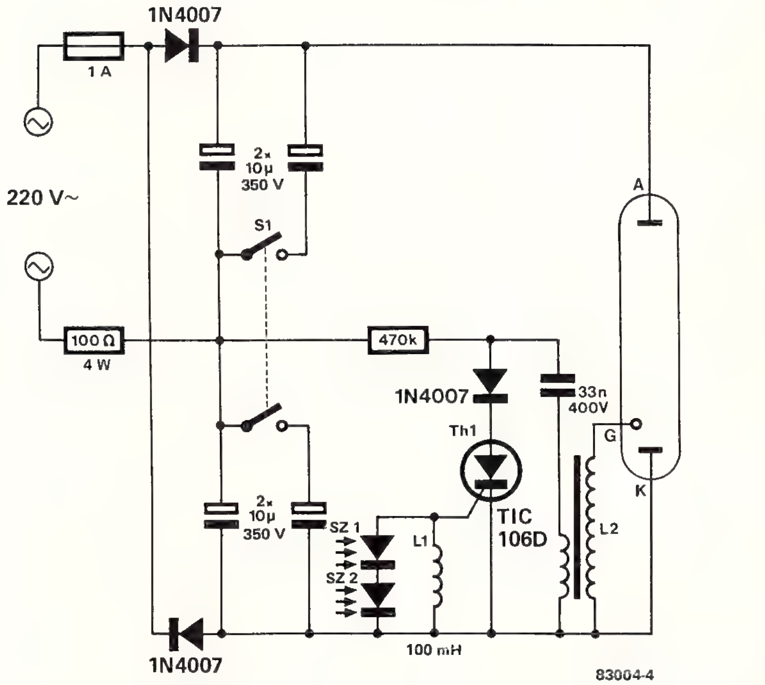
Crescendo coils and S/N ratio

Some questions were raised regarding winding of the 2 x 10 turns of coil L1 in the Crescendo power amplifier. This is clarified in the drawing.

Readers have also pointed out that the signal-to-noise ratio is missing from the 'Technical Data'. There is not much that can be measured; with no signal applied to the input, the output is absolutely quiet. Expressed in decibels, the figure is: SNR greater than 110 dB, referred to rated power.



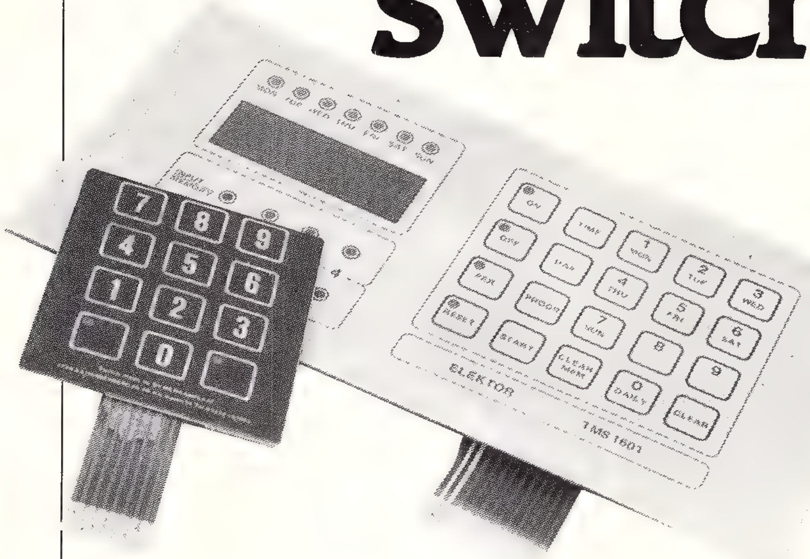
83004-5



83004-4

The membrane switch — or foil switch as it is becoming popularly known — is almost too good to be true. The switch is both reliable and inexpensive. These two factors coupled with its 'science fiction' appearance can provide the basis for a very elegant and economical keyboard that the more conventional switch cannot hope te match.

membrane switches



the super-switch of tomorrow?

If Asimov had been a hardware designer instead of a science fiction writer we would have had the membrane switch about twenty years ago! They really do have the aura of space-age technology. The most striking point about them is their appearance, they are, quite literally, wafer thin. This fact, paradoxically, is a disadvantage from the psychological point of view, they just don't look as if they can possibly be very reliable — but they are!

From the aesthetic point of view, a keyboard consisting of membrane switches has no equal. They can be any colour you like (including black), are dust proof, rust proof and would probably suffer no harm if they went through the washing machine a couple of times!

How is this list remarkable of advantages achieved? The illustration in figure 1 will help to answer many of the questions. The 'exploded diagram' shows the total absence of 'working parts'. No springs, rockers, gold plated sliding contacts, in fact, not even a terminal! Each switch consists of four layers of plastic foil that are common to all the switches in the keyboard.

The top layer of plastic is the actual keyboard panel, the part that is touched when the switch is operated. This can be coloured by a special printing process and can take any design or pattern that is desired. Further, the keyboard itself can be any shape that comes to mind, including, in some cases, bending round corners. We would like to see the toggle switch that does that!

The switch contacts are carried on two layers of flexible plastic and these are separated by a third layer of polythene foil. This 'spacer' has holes or cutouts in it that coincide with the switch contact areas in the upper and lower foils. When the front panel, or 'keyboard', is pressed, the upper contact layer us locally distorted allowing the two contact areas to 'make'. The contact areas are made from silver, graphite or a mixture of both. The insulating layer or spacer is only a few thousandths of an inch thick and therefore operating pressure is very low. This creates the misconception that the membrane switch is a true 'touch' switch, that is, a capacitively coupled solid state switch. As we have seen, this is not the case.

The complete keyboard is connected to the outside world via a flexible connecting strip. This normally pushes into an edge connector on a printed circuit board but it can also be soldered directly onto a board if needed. However, soldering such a thin (plastic!) strip is fraught with much difficulty and is not encouraged.

Advantages

The manufacture of a keyboard consisting of membrane switches is very easy. It is also economical due to that fact that a number of keyboards can be printed on a single sheet and then cut out.

The operation of a switch is simple, a soft touch is all that is required. If necessary a

1

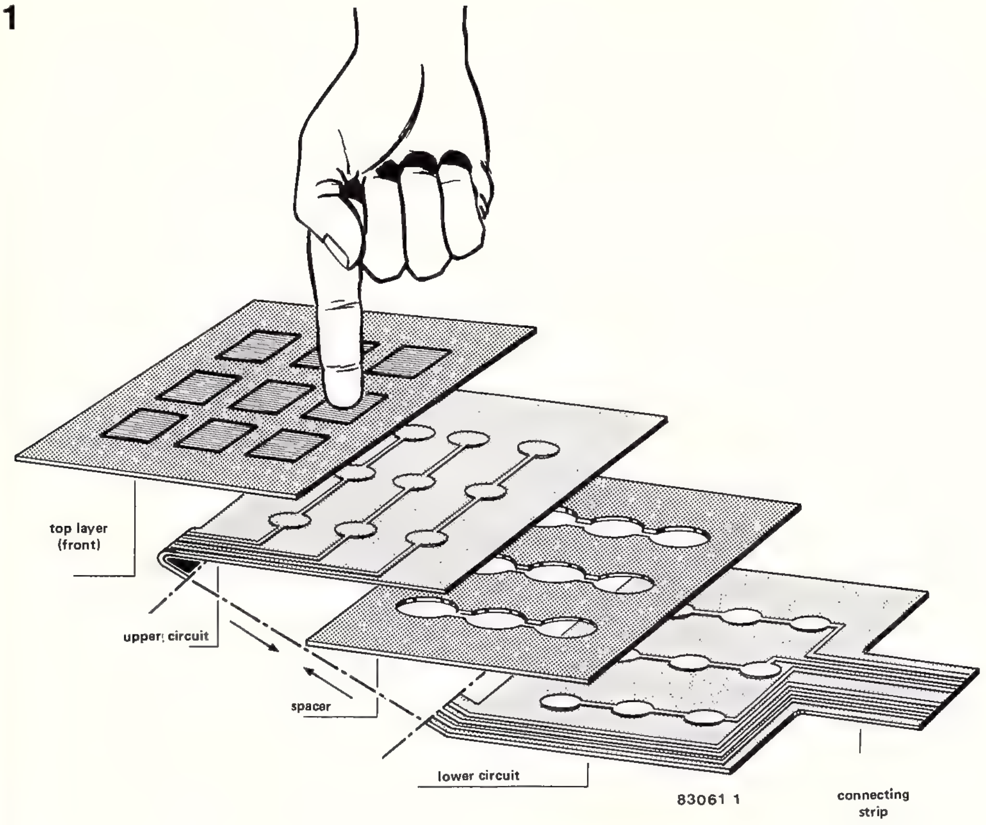


Figure 1. Membrane switches consist of four layers of plastic foil. The secret of the switch lies in the holes in the spacer. This is where contact is made between the upper and lower foils when a keypad is pressed.

light can be fitted behind the switch to show that it has been operated as anybody who has ordered a 'Big Mac' can recall.

The complete keyboard is entirely water and dust proof. Corrosion is also not a problem as very few chemical substances can attack the plastic foil used.

Mounting the keyboard is simplicity itself – it is usally backed with a self stick material and the whole keyboard is just placed on a sheet of aluminium and that is that!

As mentioned previously, shape can take many forms for any number of applications. This keyboard has no fear of that horror of horrors – the office coffee. Good keyboards have been known to die instantly from a liberal dose of this but the foil keyboard carries on quite happily. A good scrub down with a mixture of nitric acid and liquid methane will obviously be required at a later date to remove the stuff but operation is unimpaired.

Cost always rears its ugly head when anything good comes along but in this case there is a happy ending. The complete keyboard can be produced at a fraction of the cost of conventional keyboards.

What about long term reliability? With no moving parts what can go wrong? A persistently strong finger may make some impression after a hundred years or so but it is unlikely!

So we now have what appears to be the super switch of the century. Does it have no Achilles heel?

Disadvantages

If one is ill-advised enough to attempt to switch 10 amp loads with our switch it reveals a marked tendency to get somewhat 'soggy' – in a very few microseconds! (It also creates severe bluntness of the fingers.)

In all fairness, the restriction to 100 mA loads can not really be classed as a disadvantage as that is more than enough to carry out the purpose for which it was intended. Whether high current versions will eventually be produced is yet to be seen.

Switch configuration looms large on the disadvantage side of the fence. We have a choice – press to make – or nothing! Not even a single pole changeover. Here again, for their alloted task in life, that of a keyboard switch, this is sufficient.

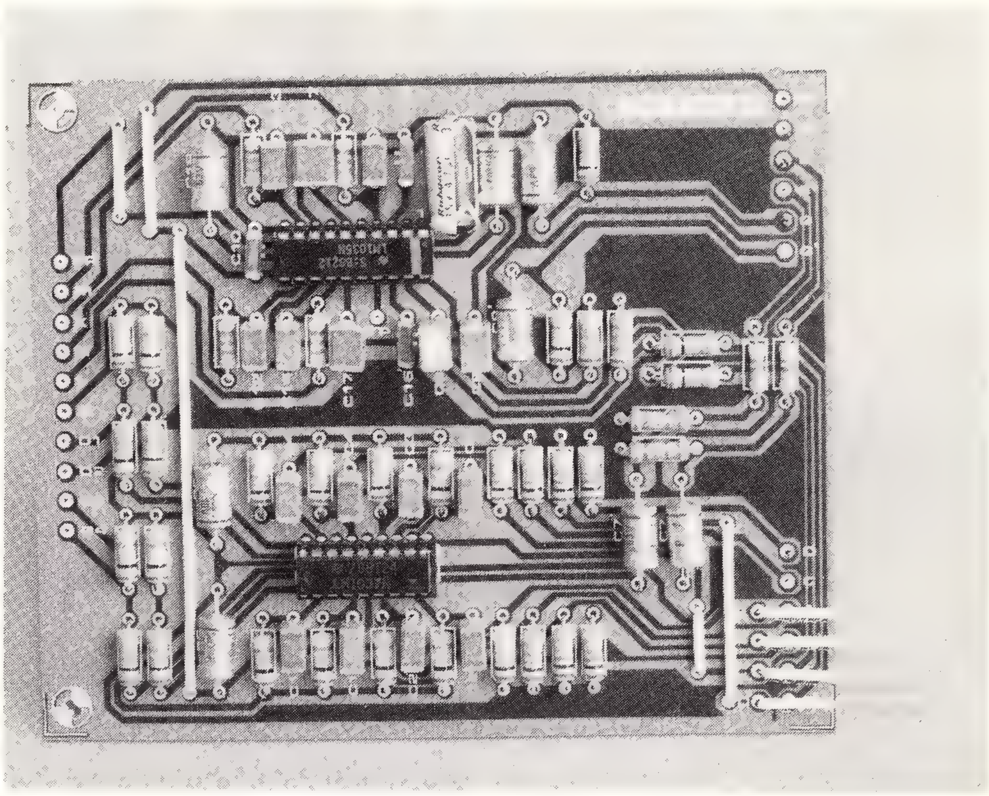
Where to use membrane switches

As we have seen, the membrane switch will not make the conventional switch in its many varieties instantly redundant. It is also not really economical where just one switch is required. However, when keyboards are considered it leaves the competition gasping for breath, especially when cost is considered.

The Elektor 7-day multi-time switch that is published in this issue makes use of a membrane keypad. It is available from the Elektor ESS service.

Technical details

thickness:	approximately 1 mm
operating pressure:	1 – 2 N
contact separation:	approximately 0.2 mm
load current:	100 mA at 30 V
contact resistance:	$\leqslant 100\ \Omega$
switching time:	1 ms
service life:	$> 10^6$ operations per contact
operational temperature:	–30°C to +65°C



The convenience of remote-control for television sets is fairly well-known. The Interlude brings the same armchair operation to the world of hi-fi audio: volume, balance, tone, even input select — all controlled from the 'ideal listening position'.

Although this unit is intended as a plug-in module for the Prelude, it is almost a complete preamplifier in its own right. You only need a little ingenuity, a few hard-wired potentiometers and a power supply!

interlude

a remote-control preamplifier

To provide a preamplifier with a remote-control facility, the first step is to ensure that all its controls can be operated by means of a DC voltage. The input selector switch, for example, could be replaced by a box of relays or by so-called analogue switches. However, relays are expensive and require heavy-duty drive circuits; conventional analogue-switch ICs are not bad, but they are not really good enough for a top-notch audio system.

The analogue controls (volume, balance and tone) are even more difficult. An ideal solution would be to use some kind of motor-drive for the potentiometers: just think of the gimmick-value of a knob that is rotated by a ghostly hand! Yes, and just think of the (mechanical) problems. Another alternative would be to use OTAs (Operational Transconductance Amplifiers) as electronic potentiometers. Unfortunately, their performance tends to be below par.

To cut a long story short: any type of remote-control system in an audio installation will have some disadvantage. Either it will be mechanically clumsy, or it will be expensive, or both; and if it is not too expensive, the quality will almost certainly be less than that offered by a more conventional preamplifier design. The solution chosen for the Prelude gets the best of both worlds, in a surprising way: use two preamplifiers! The Prelude itself is a top-quality design, using conventional controls. When switched from 'manual' to 'remote', its control section is cut out of circuit and replaced by a remote-controllable preamp: the Interlude.

This circuit configuration made the name 'Interlude' an obvious choice. Similarly, the infra-red transmitter and receiver (to be described in forthcoming issues) are called the 'Maestro' and 'Conductor', for an obvious reason: how else would you call someone who controls a musical performance from a distance? Not 'recording engineer', 'tonmeister' or 'producer', surely!

1

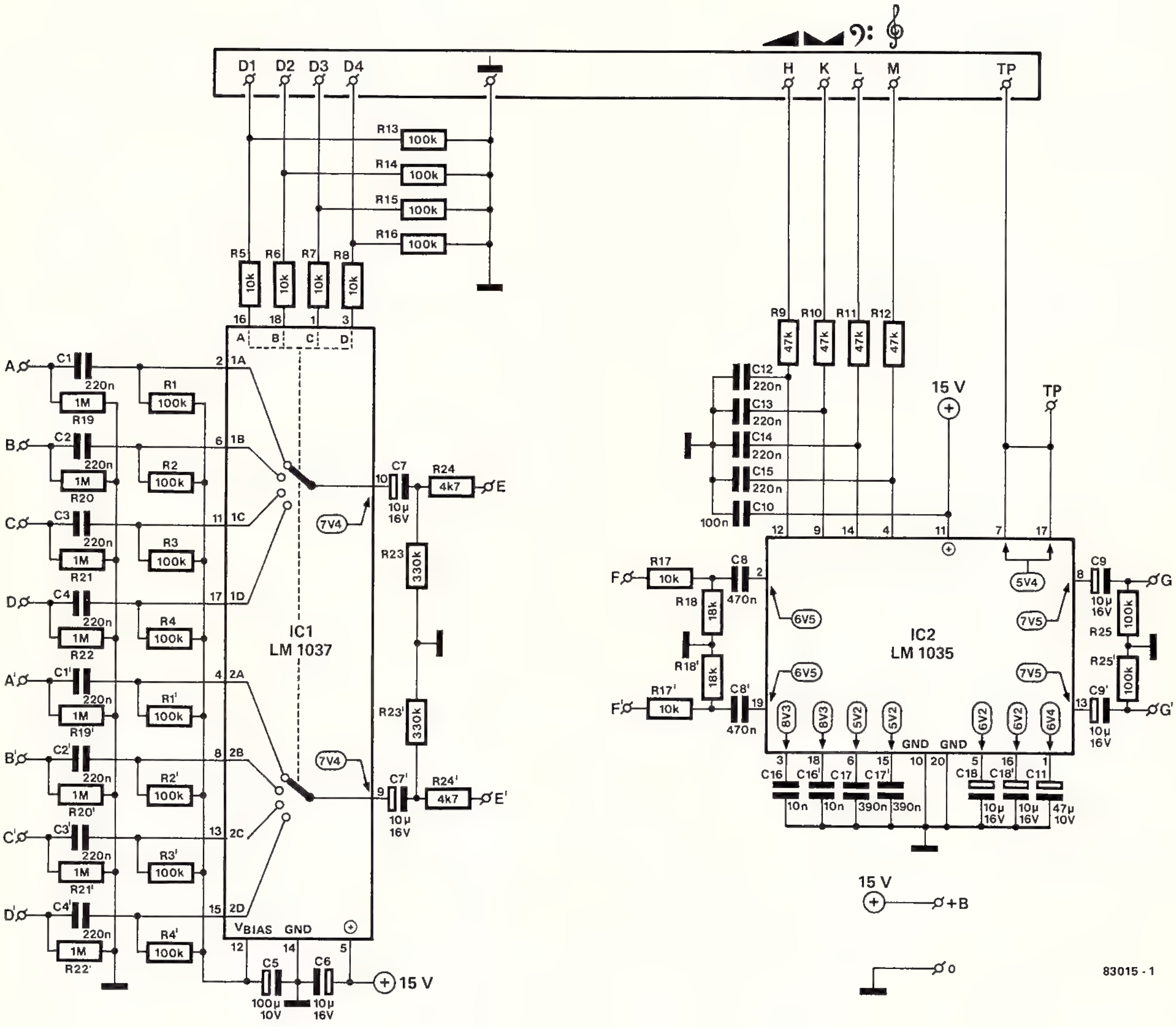


Figure 1. The circuit of the Interlude merely consists of two ICs.

Table 1

Typical technical data

Distortion factor (at 1 kHz, 1 V_{rms} output):	< 0,15%
Frequency range (+0, −1 dB):	20 Hz . . . 20 kHz
Signal-to-noise ratio	
tuner, aux, tape:	> 75 dB
MM1, MM2:	> 65 dB
MC:	> 55 dB
Tone controls: bass (40 Hz):	± 15 dB
treble (16 kHz):	± 15 dB
Cross-talk (20 Hz . . . 20 kHz):	> 40 dB
Volume control, range:	80 dB
Balance control, attenuation of 1 channel:	+1 dB . . . −26 dB

Second best?

As mentioned above, activating the Interlude means that the quality must suffer. This is the price of convenience. However, the overall specifications are not at all bad, as shown in table 1. The Interlude may not be XLent, but it certainly is hi-fi. For just two ICs, as shown in figure 1, that's not bad. These two, the National Semiconductor LM 1037 and LM 1035, are in a friendly environment of course: the input selector, IC1, only needs to select inputs of adequate level (approximately 100 mV_{RMS}). These are provided by the tuner, tape deck or whatever, or by the existing phono preamps in the Prelude. The control amplifier, IC2, needs a fairly high signal level (1 V_{RMS} or so) and this is provided by the existing line amplifier.

The circuit

IC1 is the equivalent of a double pole switch with four positions. Depending on the logic

2

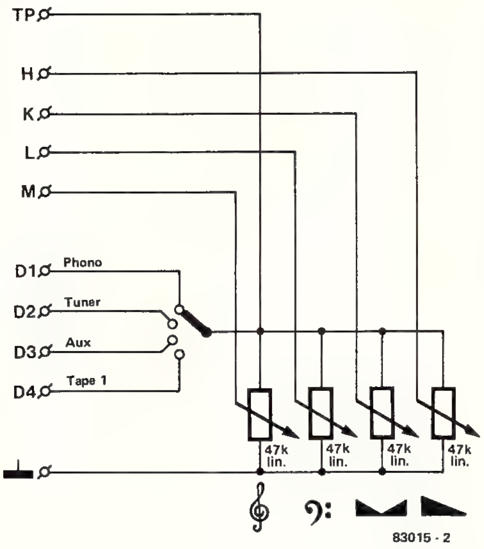


Figure 2. Cable instead of infrared. This figure shows an inexpensive way of testing the Interlude. It also shows how a simple, small preamplifier can be built with one four pole switch, four potentiometers and the Interlude printed circuit board!

levels at control inputs D1 . . . D4, the corresponding signal inputs A . . . D (A' . . . D') are switched to output E (E'). In order to select an input, a voltage of 2.5 V . . . 50 V must be applied to the corresponding control input. At a control voltage of less than 1.0 V the corresponding input is inhibited. Resistors R1 . . . R4' provide the bias voltage for the IC inputs and also determine the input impedance (in conjunction with the potentiometers on the connecting board). Outputs E and E' are low-impedance. The gain of IC1 is 0 dB (unity gain).

IC2 contains six electronic potentiometers; volume, treble and bass require one potentiometer each, times two for stereo. Balance control is achieved by varying the volume potentiometer. The latter also has the widest adjustment range: more than 80 dB. The treble and bass controls give symmetrical cut and boost: ± 15 dB at 16 kHz and 40 Hz, respectively.

The input signal for IC2 comes from the

3

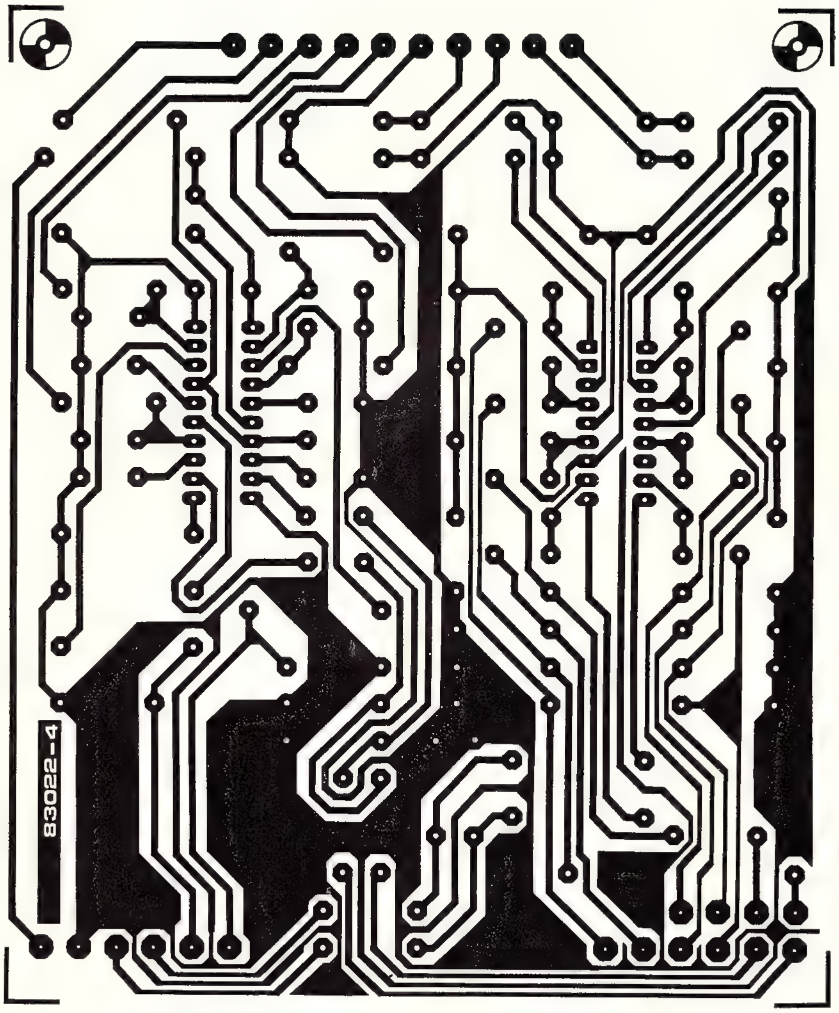
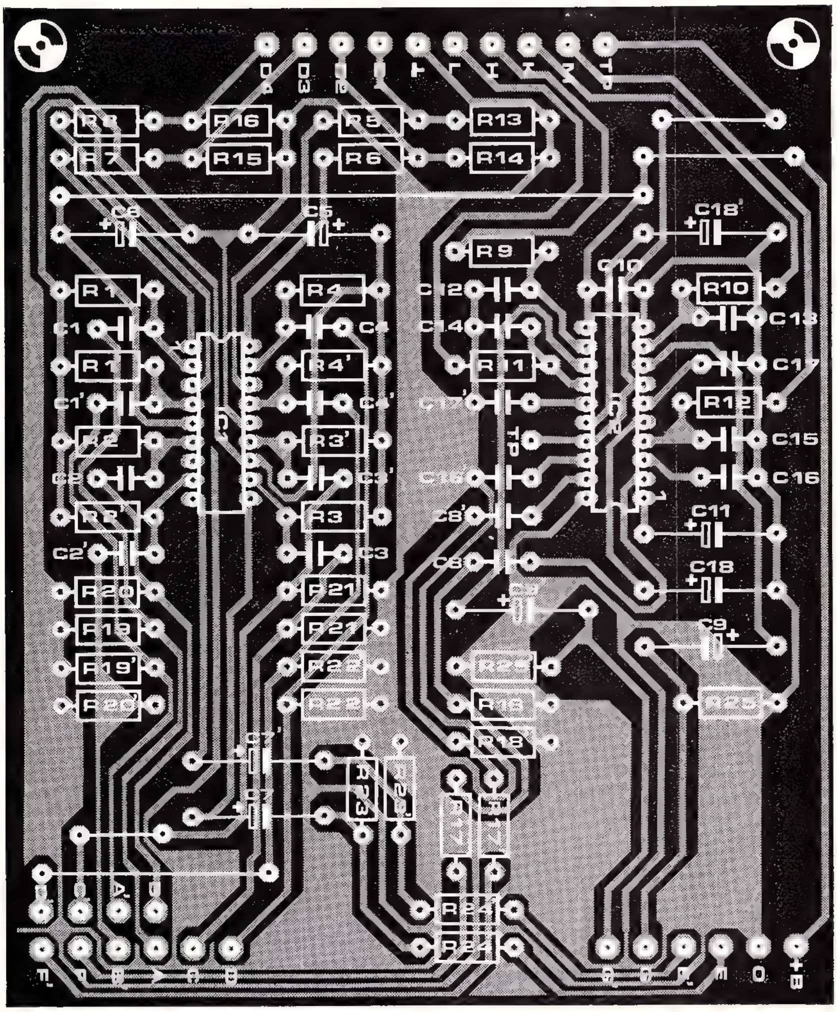


Figure 3. Terminals +B (15 V), A . . . D', E and E', F and F', G and G' and ⊥ are wired so that the printed circuit board can be 'plugged' into the bus board of the Prelude.

line amplifier of the Prelude, which delivers approximately 2 V_{rms}. This signal (at points F and F') is reduced to the optimum input level of 1 V_{rms} for the IC by means of R17/R18 and R17'/R18'.
The control voltage for the potentiometers at terminals H . . . M can vary between 0 V and the voltage at point TP (5.4 V). A load of up to 5 mA can be connected to point TP (potentiometers, for example).
The IC offers an additional feature which is not exploited in the Prelude: a loudness facility. In order to make use of this optional function, pin 7 must be connected to pin 12 instead of pin 17.

Construction

The printed circuit board is mounted on the bus board in much the same way as all the other boards in the Prelude. The connecting wires are fitted to points +B (15 V), A . . . D', E and E', F and F', G and G' and ⊥. As usual, the short lengths or wire (about 2 cms) are soldered in place and then bent parallel to the board. This very economical 'edge connector' is fitted and soldered to the bus board in the position shown in figure 3 on page 2-20 of the February 1983 issue. The printed circuit board must be fit with the component side facing to the left when looking at the front of the Prelude.
Sockets for the remote control connections can be mounted on the rear panel of the case just behind the printed circuit board. Either one ten pole socket can be used or, perhaps more economically, two five pole sockets. These latter can be ordinary DIN sockets but, to avoid confusion, they should be of different configurations (for instance, one 180° and the other 270°).
The Prelude is now ready for remote control. The circuits for the infrared transmitter and receiver will be published next month. Meanwhile, the circuit shown in figure 2 can be used for testing.

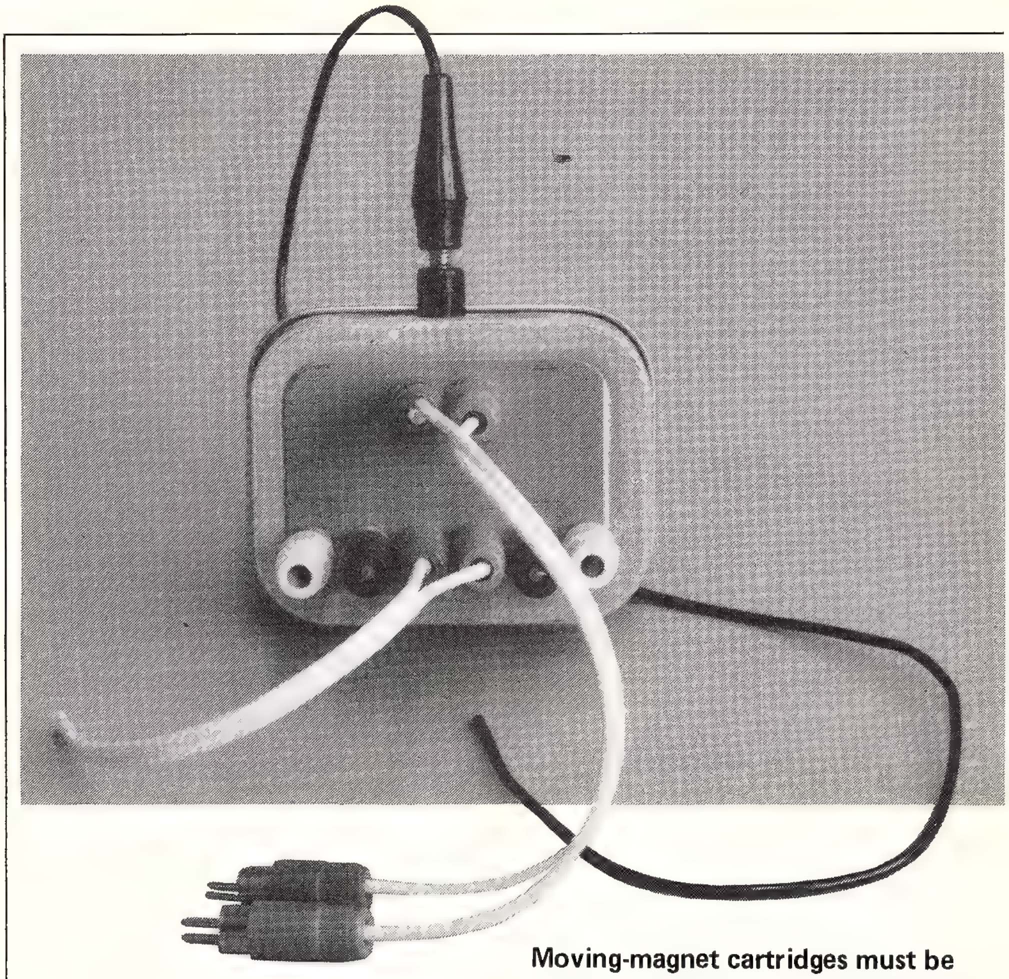


Parts list

Resistors:
R1 . . . R4, R1' . . . R4' = 100 k
R5 . . . R8,R17,R17' = 10 k
R9 . . . R12 = 47 k
R13 . . . R16,R25,R25' = 100 k
R18,R18' = 18 k
R19 . . . R22, R19' . . . R22' = 1 M
R23,R23' = 330 k
R24,R24' = 4k7

Capacitors:
C1 . . . C4, C1' . . . C4', C12 . . . C15 = 220 n
C5 = 100 μ/10 V
C6,C7,C7',C9,C9',C18, C18' = 10 μ/16 V
C8,C8' = 470 n
C10 = 100 n
C11 = 47 μ/10 V
C16,C16' = 10 n
C17,C17' = 390 n

Semiconductors:
IC1 = LM 1037 (National Semiconductor)
IC2 = LM 1035 (National Semiconductor)



frequency response equalisation for moving magnet cartridges

RC equalizer

Moving-magnet cartridges must be terminated with the proper impedance in order to achieve optimum sound. This article attempts to clarify the electro-acoustic factors involved and presents a simple and inexpensive method of obtaining a great improvement in sound response.

Anyone who has purchased a record player or amplifier after extensive listening tests in a hi-fi studio will have noticed two things:

1. Each record player and each amplifier sounds different.
2. The new piece of equipment sounds different at home than in the shop.

One should not be tempted into resignation in the face of these idiosyncracies of audio-electronics. These differences in sound have a perfectly rational explanation and can be measured. The only question is how.

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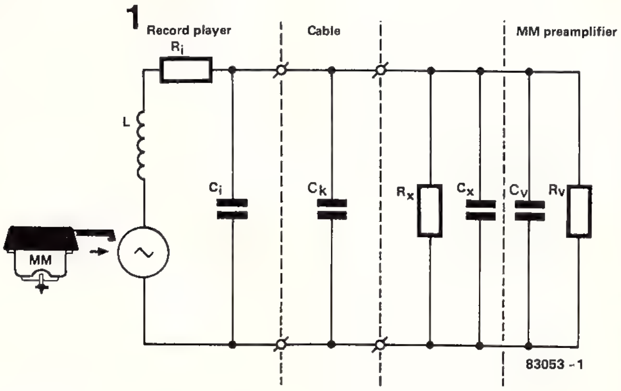

Figure 1. The electrical equivalent circuit of a moving magnet cartridge, connected to the pre-amplifier by a cable.

Cause and effect

The causes of the differences in sound can be found in the construction of a moving magnet system, and are explained by the equivalent circuit of this type of pick-up in figure 1. The stylus is connected to a small permanent magnet. Coils are arranged in its magnetic field and the field variations caused by stylus movement are converted to a varying voltage by these coils.

This type of coil has many turns. Since there is very little space in the cartridge, the wire used for the windings is very thin. In addition to the coil inductance (L: 200 mH . . . 1 H), this leads to a considerable internal resistance (R_i: 200 Ω . . . 1000 Ω) and capacitance (C_i: coil and cable, up to 100 pF).

Cartridges are designed to exhibit a flat frequency response when terminated with a particular impedance. In conjunction with the terminating impedance, the influence of L, R_i and C_i is neutralised. The DIN standard specifies a terminating impedance of 47 k/400 p.

Everything would therefore seem to be in order as long as $C_L + C_x + C_p$ result in 400 pF, and R_x and R_p in parallel have a value of 47 kΩ.

But things are seldom so clear-cut. Manufacturers of cartridges and hi-fi equipment tend to interpret this standard as 'merely a guide'. Cartridges are actually designed for terminating impedances of 33 kΩ . . . 100 kΩ and for terminating capacitances of 80 pF . . . . 1 nF; and readers who follow the tests in hi-fi magazines will have noticed that the input impedances of preamplifiers for magnetic pick-ups often deviate considerably from the values specified. Only so-called high-end equipment is provided with a means of selecting the input impedance.
It is therefore no wonder that different performance is encountered when record players and amplifiers are combined in a system.

Phono-equalizer

Since we cannot change the cable capacitance C_L anymore than we can change the construction of the pick-up system, the only solution is to match the preamplifier.
Within certain limits, this is possible without modifying the unit, using a so-called phono-equalizer. This accessory is a box which is inserted in the line to the pick-up (or 'phono') input of the amplifier. Various capacitors and resistors can be switched in parallel with the input by means of push-buttons or other switches. In view of the very low cost of the components used in this accessory, it is clear that one is mainly paying for the technically sounding name 'phono-equalizer'. Furthermore, there is no quarantee that this accessory will result in any improvement.
According to the usual operating instructions, a record with plenty of overtones should be played and different settings should be selected on the phono-equalizer, until the sound is 'right'. In many cases, however, the result is merely a difference in sound and not a technical improvement. At any rate, it is not a solution worthy of the name 'hi-fi'.

RC equalizer

A better solution is to use an RC equalizer. As shown in figure 2, this accessory for home-construction simply consists of a metal box with two input sockets, two output sockets and four extra sockets.
The input and output sockets are interconnected; the box is therefore inserted in the line from the record player to the amplifier like a phono-equalizer. The extra sockets are intended to accept Cinch plugs containing a small capacitor or resistor.
In this way we have the equivalent of a phono-equalizer, i.e. a facility to connect capacitors and resistors in parallel with the input of the amplifier, but at much lower cost and with more flexibility.
The sockets must be insulated from the metal case; this is important to avoid hum. The easiest way to achieve this is to use plastic washers of a suitable diameter. The metal case then has an earth from the turntable, which is usually separate on most record players, and another terminal for the earth conductor to the amplifier.

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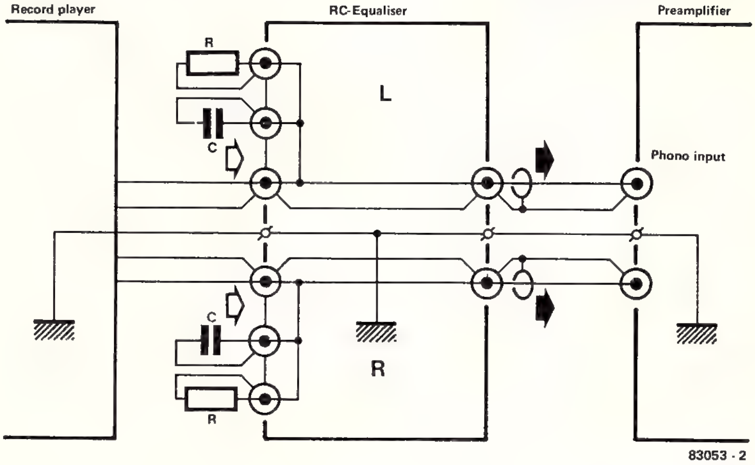

Figure 2. The RC equalizer. Since it only consists of a box with six Cinch sockets and four additional plugs, it is considerably less expensive than a commercially available phono-equalizer.

Incidentally, an RC equalizer of this type is already provided in the latest Elektor preamplifier – the Prelude.

Equalising

We now have a box with which we can connect capacitors and resistors as desired. So far so good. But what values do we need? We could consult the manufacturer's literature to establish what load impedance is required by the cartridge and what input impedance is provided by the preamplifier. Alternatively, we can use a test record. This should include a sinewave sweep from 50 Hz to 20 kHz or so.
Measurements can be done by ear, with the aid of the test circuit of figure 3 and a conventional, analogue multimeter. With the RC equalizer in circuit, we can now set to work.

1. Set the tone controls to their midpoints or, even better, switch them off if possible; cancel all filters (subsonic, loudness, etc.).
2. Play the record with the sweep, and adjust the volume record to obtain a readable deflection on the multimeter (test circuit connected to the loudspeaker output).
3. If the deflection remains constant at high frequencies (± 15% of the value for low frequencies is acceptable), the system is in order and no RC equalizer is needed.

If, however, the deflection clearly changes as the frequency rises, continue with the actual alignment: starting with small values for C (10 pF . . .) and high values for R (1 M . . .), solder capacitors and resistors into the Cinch plugs. With the capacitor plugs and resistor plugs inserted in the auxiliary sockets, play the record with the sweep again and observe the deflection on the multimeter. This is repeated with different values of C and R until the flattest frequency response is obtained. It should be noted that C and R are mutually interactive.
If the frequency response can only be worsened with the RC equalizer, the input impedance of the preamplifier must be too low already. This means modifying the input circuit, but this is best not attempted without a circuit diagram. ◼

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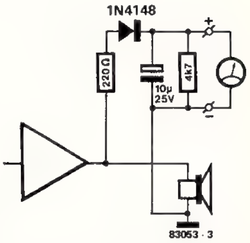
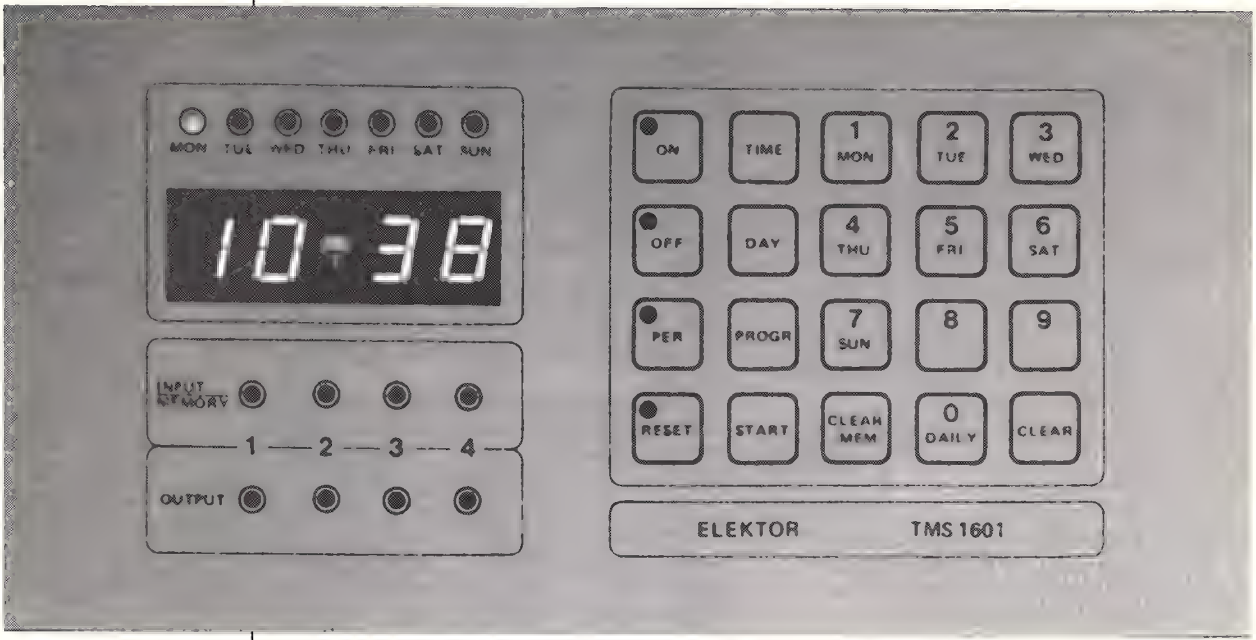


Figure 3. This test circuit allows even the highest frequencies to be measured with accuracy. It is connected in parallel with the loudspeakers.

The last time we published a single-chip programmable timer was way back in May 1979 and the circuit became very popular (and still is). However, the IC used at the time is now a little 'thin on the ground' and it's about time the subject was brought up to date. The circuit here uses the TMS 1601 from Texas Instruments, a single-chip microcomputer specifically designed for this purpose. It doesn't, as the subtitle may suggest, actually stop and start time itself (that article will be published in an earlier issue) but it will do almost anything else. Sophistication doesn't end there either. The front panel that is available from the EPS service also contains the keyboard, consisting of built-in membrane switches. This represents another first for Elektor and gives the finished project a very professional appearance.

7-day timer/controller



a micro computer controlled time switch

The TMS 1601 timer/controller IC from Texas Instruments forms the basis of this circuit and, as can be expected, carries out most of the work. So what does it actually do? Briefly, it is a single-chip pre-programmed microprocessor dedicated to timer applications. It forms a 24 hour clock using seven-segment LED displays and provides four outputs that can be programmed for daily or weekly cycles (or both). It will also display the days of the week. With the aid of an external RAM (one of the few extra ICs) 28 different times can be programmed for each output per week. Alternatively, four switching times for each output can be set to repeat daily. In total, this means enough switching times per week to take care of Coronation Street and Dallas and egg for breakfast every morning and still open and shut the garage door morning and night (weekdays only) without even struggling! Oh, and don't forget the porch light!

Contrary to what you might expect, programming this unit is a fairly simple matter. For example, say that the porch light needs to be switched on every saturday evening for a certain period of time. Using the

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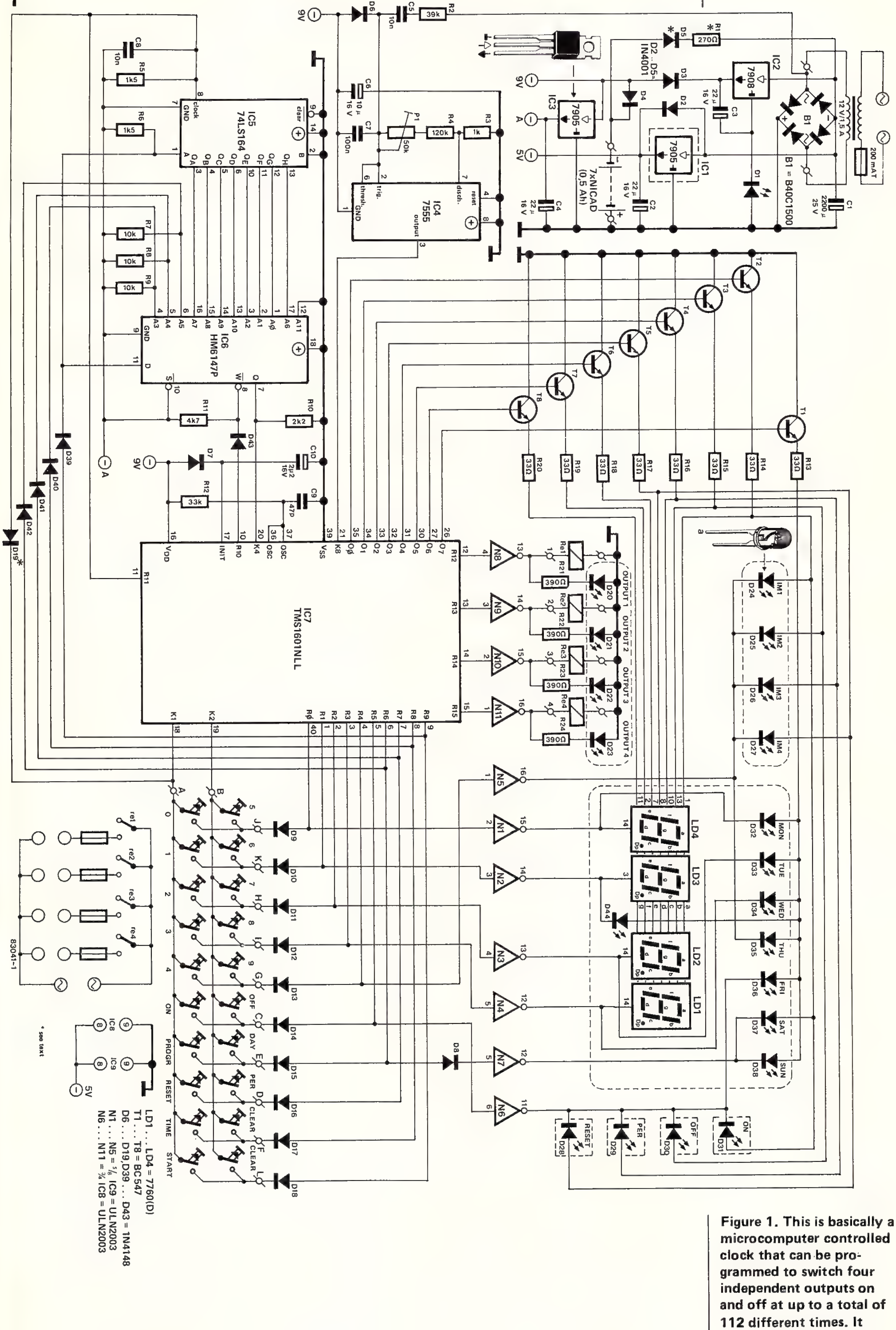

Figure 1. This is basically a microcomputer controlled clock that can be programmed to switch four independent outputs on and off at up to a total of 112 different times. It can even provide a four-day week if asked!

Missing link?

For complete flexibility, it should be possible to program a mixture of 'weekly' and 'daily' times in one switching sequence. Unfortunately this is not possible — contrary to the manufacturer's specifications — as we discovered when testing our prototype. We have been informed that there is indeed an error in the programming mask for the chip. TI is reluctant to correct this, which seems rather a pity —

Ed.

keyboard, key in the day of the week followed by the switch-on time and then the switch-off time. That's all there is to it! Alternatively, if the porch light needs to be switched on every evening, as it probably will, simply press the 'DAILY' key.

All switching times that are stored in memory can be displayed whenever required. Each or all of them can be deleted or modified easily. There is also a 'reset' facility that may be of interest to people who have an application involving repeated 24 hour cycles, but more of that later.

One other mode of operation exists that can be very useful. It is possible to switch any output manually at any time without affecting the program stored in the memory. This has the added advantage that the timer can also be used as a central control point for all the appliances that are connected to it. Appliances can be connected to the timer via relays or solid state switches. These in turn can be mounted in the appliance itself or in the same housing as the timer. This allows the possibility of driving equipment using only low voltage wiring, a useful asset in a number of situations.

A final detail that is not the least in importance. The circuit has been equipped with emergency battery backup. This ensures that in the event of a mains failure the clock continues to run and the memory remains intact.

The circuit diagram

About a dozen or so years ago, the detailed description of the circuit diagram for this project would probably have required a small book! Fortunately this is not the case today as a glance at the circuit diagram of figure 1 will show. The heart of the circuit is IC7, the TMS 1601. This IC is a dedicated timer/controller microprocessor and we would not get anywhere without it (in this circuit at least). It contains an internal clock oscillator, 4 K byte ROM, 512 bit RAM and the four-digit seven-segment display decoder and multiplexer among other bits and pieces. Quite a tally for one IC!

The keyed in information is stored in an external RAM, IC6. Three of the address lines for this memory are driven directly by IC7 while the others are controlled by a shift register, IC5. In its turn IC5 gets its information from output R9 of IC7, clocked in by a signal derived from output R11 (IC7).

The output control relays (or solid state switches if preferred) are switched via buffers (N8 . . . N11) from the R12 . . . R15 outputs of IC7. An important point to note here, the quiescent current of the output devices must not exceed 80 mA. The LEDs D19 . . . D22 indicate the state of each output.

The membrane keyboard is connected between outputs R0 . . . R9 and K1 and K2 of IC7. The key functions will be described later. The four seven-segment displays are multiplexed by IC7. The digit select outputs are R0 . . . R3 and these are buffered by display drivers N1 . . . N4 in IC9. Segment control is from outputs 00 . . . 07 and here transistors T1 to T8 are the buffers. The remaining display outputs R4 . . . R9 take care of the rest of the LED indicators (16 in all). It will be as well to list what these are. LD1 to LD4 are of course the seven-segment displays. These are accompanied by: a decimal point (D44), the days of the week (D32 . . . D38), the memory input LEDs (D24 . . . D27), an LED for the 'reset' (D28) and 'period' keys (D29) and finally the LEDs for the 'on' and 'off' keys (D31 and D30 respectively).

The clock signal for IC7 is devired from the 50 Hz mains frequency and taken from the secondary winding of the transformer. The waveform at this point is used to synchronise the 7555 (IC4) which is connected as an astable multivibrator with a frequency of ~ 50 Hz! This apparent 'over-engineering' not only gives us a good square wave for the clock signal but it also serves as a clock oscillator if the mains supply fails. The frequency setting components in this case are resistor R2 and capacitor C5. This leads the story on to the power supply (emergency and otherwise).

Two voltage levels are required for the circuit, −5 V and −9 V. Both are achieved by the use of voltage regulator ICs. The −9 V is the province of IC2; the −5 V supply consists of two sections, the supply for the display (IC1) and the rest of the circuit (IC3).

In the event of a mains failure (when panic sets in round the freezer!) the 7 NiCad cells take over — but not quite everything. The −9 V for IC4 and IC5 together with the −5 V for ICs 5 and 6 are maintained. This ensures that the clock continues to run and the memory remains intact. The display, with its relatively heavy current consumption, must go and so we lose that. The correct time is of course retained, it just means that it is no longer visible. Also we lose the drive to the relays, another heavy current consumer. This is not such a disadvantage however. How will the switched appliances operate during a mains failure? Unless of course someone invents a NiCad capable of opening a garage door by the time this gets into print! In the emergency situation the current requirement for the whole circuit does not exceed 50 mA and the NiCads can cope with this for quite a while. If the NiCads are to be replaced by non-rechargeable batteries R1 and D5 must be removed. These two components provide a 'trickle charge' for the NiCads.

Front panel controls

This section can be taken as a small commercial for our front panels which are self adhesive, scratch proof and washable. They also have that deep-down colour that will not fade if . . . but enough of that! On to the nitty-gritty!

The layout of the front panel is illustrated in figure 2. The control functions (an up-market term for keys and LEDs) can be decribed as follows:

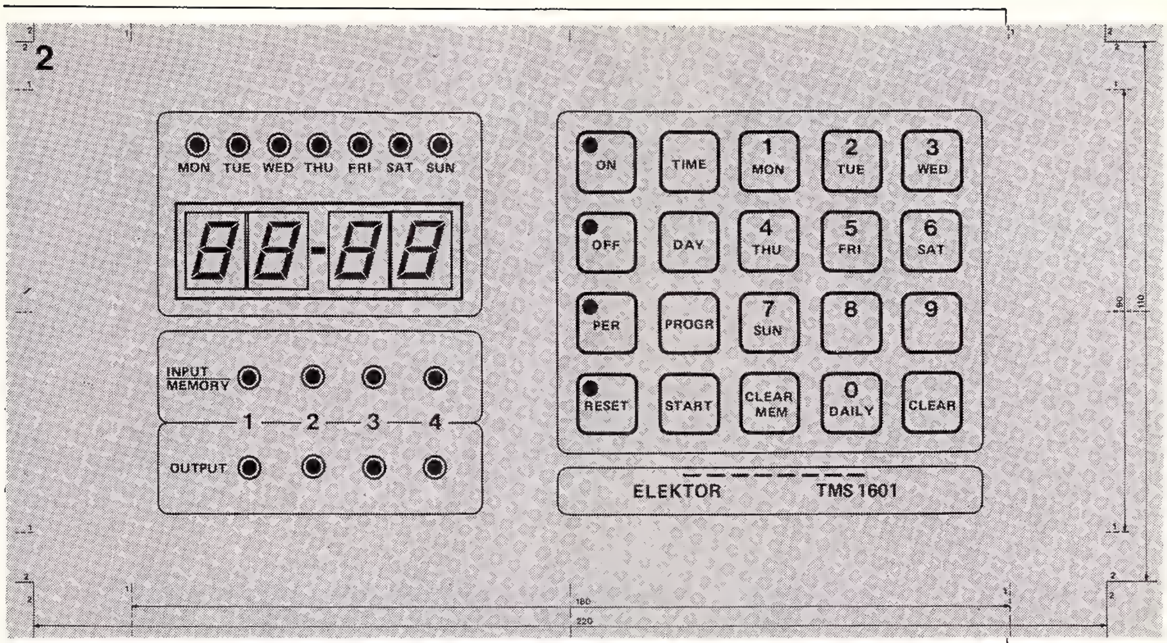

Figure 2. Ultra-thin membrane switches make it possible for the keyboard and front panel to be combined into one. The transparent covers for the display and LEDs are also part of the front panel.

MON TUE WED THU FRI SAT SUN : It may come as a surprise but these LEDs indicate the days of the week!

88-88 The four digit time display. It is used to indicate the switching times during programming. (This is also true for the 'day' LEDs.) The centre LED flashes once a second.

INPUT MEMORY 1 2 3 4 : Four LEDs that indicate which of the four outputs is being programmed.

OUTPUT These LEDs indicate the state of the outputs.

ON : This key will switch on one of the outputs during the programming procedure or when under 'manual' control. The key lights when a switching 'on' time is entered.

OFF : As above, but for 'on' read 'off'!

PER : This key is used before entering a time 'period' in place of a specific switch off time. The LED will light to denote that the next entry parameter will be a period.

RESET : Similar to above but in this case it is a 'reset' time that will be entered and the LED will prove the point.

TIME : The key used to start the clock or to switch the display back to real time (after a programming entry for instance).

DAY : Used to select a particular day during programming or when setting the clock.

PROGR : A switching output can be programmed by operating this key followed by 1, 2, 3 or 4.

START : This key is only used to get the clock out of the condition called 'single reset'. It will not be used very often and the reasons for this will be explained later.

CLEAR MEM : Remember this key because it will wipe out the entire memory if operated in error. It will do exactly the same job if operated on purpose but without anything like the same sort of after effects!

CLEAR : Deletes an incorrect key entry and clears the display.

1 MON 2 TUE 3 WED 4 THU 5 FRI 6 SAT 7 SUN 8 9 0 DAILY : These are dual function keys depending on the entry order of the specific program.

Operation

From the word go . . .

As soon as power is applied to the circuit the four displays will flash figure 8's and the 'second' LED stay out. The memory will of course be empty and the clock will not run. This condition will also occur whenever the mains supply is lost and no emergency battery backup has been included. Need we say more?

Starting of the clock

We get off to a good start by using, as an example, 17.30 on a Friday afternoon! Did you expect 08.00 on a Monday morning?

■ Press the TIME key	: The MON LED will light and the display will show 00.00. This is quite correct because the cycle of the clock begins at 00.00 on Monday and ends at 24.00 on Sunday. The 'seconds' LED will light but not flash.
■ Press DAY	: The DAY LEDs will now start to flash.
■ Press FRI	: The FRI LED will light continuously

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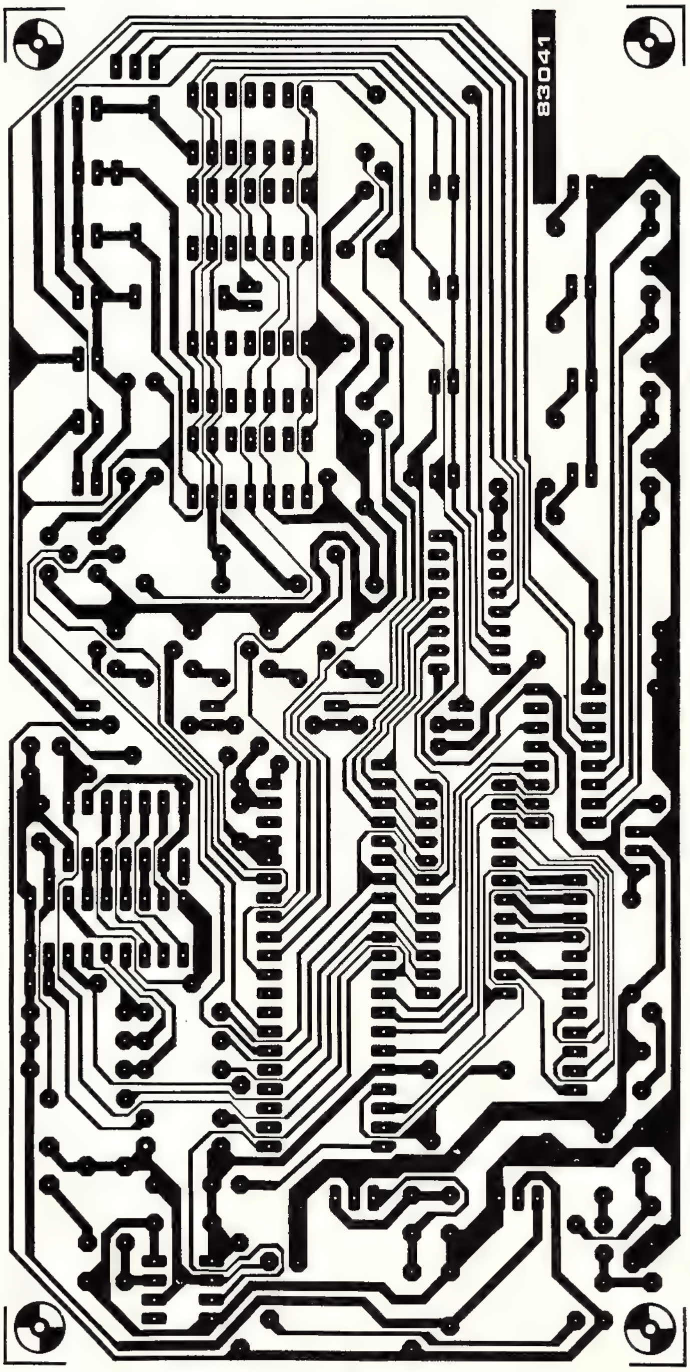

Parts List

Resistors:
R1 = 270 Ω
R2 = 39 k
R3 = 1 k
R4 = 120 k
R5,R6 = 1k5
R7,R8,R9 = 10 k
R10 = 2k2
R11 = 4k7
R12 = 33 k
R13 . . . R20 = 33 Ω
R21 . . . R24 = 390 Ω
P1 = 50 k preset

Capacitors:
C1 = 2200 μ/25 V
C2,C3,C4 = 22 μ/16 V
C5,C8 = 10 n
C6 = 10 μ/16 V
C7 = 100 n
C9 = 47 p
C10 = 2μ2/16 V

Semiconductors:
D1 = Red LED
D2 . . . D5 = 1N4001
D6 . . . D19,D39 . . . D43 = 1N4148
D20 . . . D38 = Red LED, 3 mm ϕ
D44 = Red LED
T1 . . . T8 = BC 547
IC1,IC3 = 7905
IC2 = 7908
IC4 = 7555
IC5 = 74LS164
IC6 = HM 6147 (Hitachi) or 2147 (NEC)
IC7 = TMS 1601 (Texas Instruments)
IC8,IC9 = ULN 2003

Miscellaneous:
LD1 . . . LD4 = 7760
B1 = Bridge rectifier B40C1500
Tr1 = Mains transformer 12 V/1.5 A
Cabinet CL2 AFJ from West Hyde
Connector for keyboard contact strip available from Technomatic Limited

while the rest of the DAY LEDs will go out.

- Press the 1 7 3 0 keys in that order.

This time will now appear on the display.

- Press the TIME key again and the displayed time will be entered into the memory.

The clock will now run – as indicated by the flashing 'second' LED. This will always be the case when 'real' time is displayed.

Time corrections

Changing the clock time (for British Summer Time for example) is almost identical to the initial starting procedure with the exception that the CLEAR key must be operated after the TIME key and before the DAY key.

Resetting

As stated previously, the clock cycle begins on Monday at 00.00 and ends on Sunday at 24.00. This can be altered if desired to another cycle period of less than seven days. If a reset time is entered the clock will, on reaching that time, 'jump' back to 00.00 Monday and repeat the shortened cycle again. Even this can be changed. If necessary,

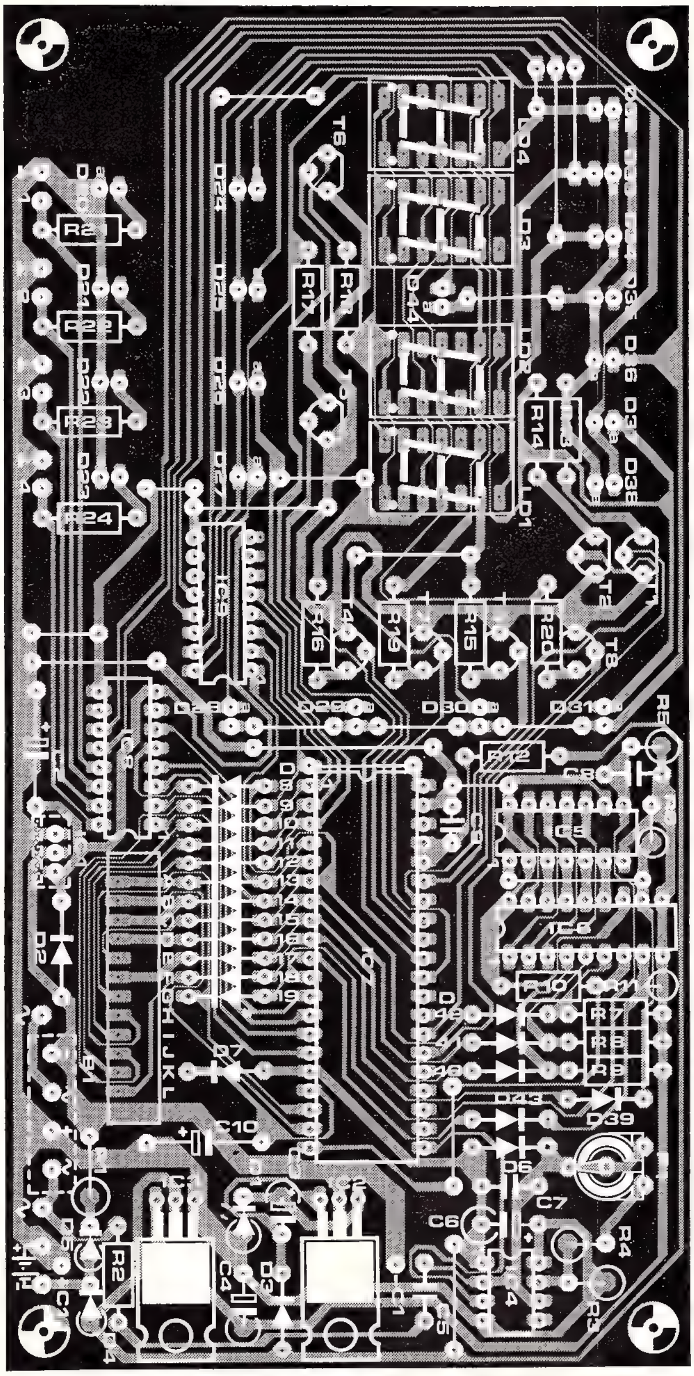

Figure 3. The keyboard is attached to the printed circuit board by means of a flexible flat connector strip. It is simply pushed into the edge connector on the printed circuit board.

the clock can be made to stay at 00.00 Monday when it returns there. This is called the 'single reset' mode and can be achieved by the removal of D19 from the circuit. When the clock enters into the single reset mode it can only be restarted by pressing the start key.
The reset time is entered in the following manner (again using 17.30 Friday as an example).
RESET DAY FRI 17.30 RESET.
The 'reset' LED will remain lit for the period of time that the reset time is stored in the memory. The reset time can be erased from the memory by operating the RESET followed by the CLEAR MEM keys. The stored reset time can be displayed at will by operating the RESET key twice in succession.

Manual control of the outputs

It is a simple matter to control the outputs manually if necessary. If, for example, it is required to switch on output 1, the sequence is:
PROGR 1 ON and there it is! This output will remain on until another (manual or program) instruction arrives to change it. Pressing the TIME key will cause the normal time to reappear on the display.

Programming switching times

One point must be made quite clear before moving on any further with this section. As mentioned earlier, there are two 'types' of programming times. There is the daily cycle where the timing point occurs every day, and there is the weekly cycle where the specific timing point may only occur once during the week (07.30 Friday for example). As mentioned earlier, these modes cannot be mixed in one program sequence! A further point to bear in mind is that if, by chance, the same output is switched at the same time in either the weekly cycle or the daily cycle, that output will just be 'inverted' from what it was, irrespective of what the programs said it should do.
To program a switch-on time for output 1, key in:
PROGR 1 DAY FRI 1 7 3 0 ON
Two things may happen after pressing the ON key.

1. It is possible that the display disappears for a short period while the program is being written into memory. This is not a problem and is no cause for alarm.
2. The number 1 output will be switched on if the time entered is earlier than the time indicated on the display.

Entering a 'daily' time is almost identical to the above program. In this case the DAILY key is operated instead of the 'day' (FRI) key. The sequence of events then, for output number 1 to switch off at 23.00 every evening, would be:
PROGR 1 DAY DAILY 2 3 0 0 OFF
Note that all 'day' LEDs will light when programming a 'DAILY' function.

Programming hints

Point 2 mentioned above states that when programming switching times that are earlier than the time displayed at that moment, the output (or outputs) will switch on or off depending on the program instruction being entered. This can be avoided to a certain degree by entering the last switching time (that is before the actual time) first. The corresponding output will then remain in that condition.
It is not necessary to enter switching times in any particular order as the computer deals with this problem personally!
Another tip! It is not necessary to operate the PROGR and DAY keys repeatedly when entering a sequence of switching times for one output. The following example will clarify this. It is required that output number 4 is to switch on at 7.00 and off at 12.30 on Wednesday.
PROGR 4 DAY WED 7 0 0 ON
followed by:
1 2 3 0 OFF

Period (PER) function

Using the PER key is an alternative method of indicating the switching off time. In the event that output number 3 is to be switched on at 9.00 on Monday and remain in this state for a period of 6 hours, the program would look like this:
PROGR 3 DAY MON 9 0 0 ON
and then:
6 0 0 PER
the display will now show the switch off time that has been calculated by the computer and stored in memory (15.00 in the example here).

Displaying and clearing switching times

Human memories, regretfully, do not measure up to the short term performance of 'solid state' memories. Therefore it is quite likely that a reminder may be required. In order to display the first programmed time for an output, this apparent nonsense is entered:
PROGR 1 PROGR PROGR
followed by:
PROGR PROGR
This will cause all the switching times that are stored in memory for that output to be displayed in chronological order. If nothing has been entered for that output the displays will show 8's and all other LEDs will light.
Clearing the stored switching times is very similar to the above procedure. Now the CLEAR MEM key must be used when the time in question appears on the display. This time is then cleared and the processor will display the next switching time when the PROGR key is pressed once.
If necessary, it is possible to clear the whole program for a given output in one go. For output 1 for example:
PROGR 1 CLEAR MEM
For really drastic measures, the whole memory contents can be wiped out.
CLEAR MEM CLEAR MEM
. . . and there it was – gone!

Errors

. . . and the last entry is keyed in to complete the program and . . . the display starts flasing 8's, the 'seconds' LED gives up and panic is about to break out! It's difficult to decide whether to make a dive for the mains plug or lift the box up to stop it from scorching the table top . . !

Panic not, for what you are receiving is simply an 'error' indication. In this case an incorrect key was pressed (the last one of course) and this can be rectified by either pressing the correct one or using the CLEAR key and starting all over again. Don't you just know which method it will be!

It is also possible for the displays to show 8's but the 'seconds' continue to function. This is a memory error or 'overflow' (caused by trying to fill the same memory area twice). Afraid it's back to the CLEAR key!

Construction

We really should have a short commercial here extolling the undoubted virtues of printed circuit boards, front panels and membrane-switch keyboards designed specifically for the job but we will forego that for the moment. Instead we move on to figure 3 which illustrates the component layout for the printed circuit board. All the components shown in figure 1 can be mounted on this board with the exception of the transformer, the NiCad cells, the relays and the keyboard.

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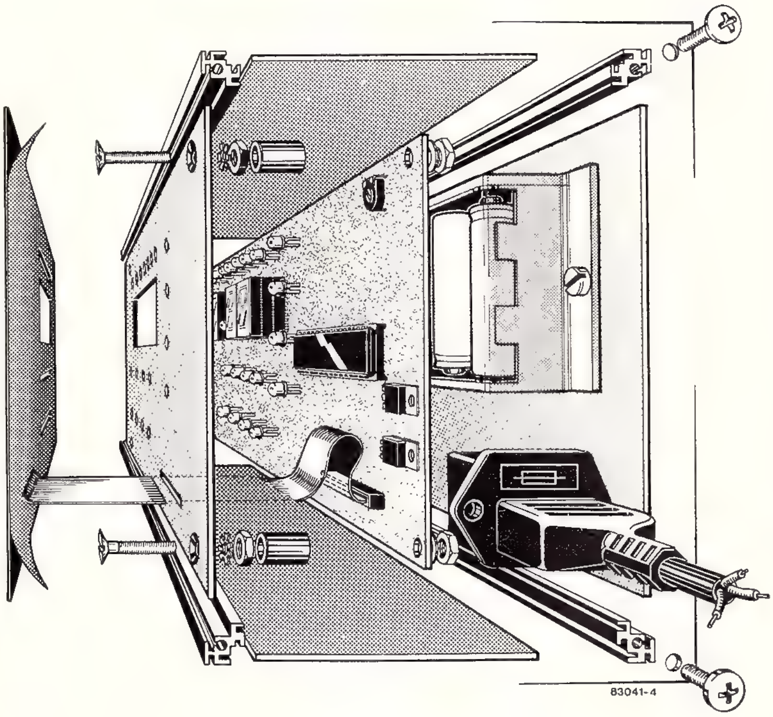

Figure 4. This drawing illustrates the construction. The printed circuit board, the front panel of the cabinet and the self adhesive front panel form one combined assembly.

Two components demand particular attention and these are the electrolytic capacitor C1 and the bridge rectifier B1. These are mounted last, not on the front but on the trackside of the board. It will be necessary to place a layer of insulating tape between the body of the electrolytic and the board to prevent any untoward horrors from occuring.

Keyboards have a history of being rather difficult to mount properly. There is all that soldering and that great gaping hole to cut which never seems to quite line up correctly (although it did when you started!). This time we have solved the problem – as if you didn't know by now! Not one solitary screw is required because the membrane switch keyboard consists of a number of layers of plastic foil and consequently is very thin (a matter of a couple of millimetres). In fact, it is an integral part of the front panel. For a more detailed description of membrane switches refer to the separate article on the subject elsewhere in this issue.

The front panel, together with keyboard, is self adhesive and only needs to be placed on the front of the chosen cabinet and pressed home. The keyboard contacts 'come out' on a flexible flat plastic strip which is attached to the printed circuit board by pushing the strip into a connector that is mounted on the board.

Figure 4 provides an indication of how the prototype looks. Construction is straightforward and only requires the usual patience and attention to detail. We used a metal case so that the entire circuit can be effectively screened. This is done by connecting the case to the supply zero. It will be found preferable to use a case that enables the front panel to be removed as there are a number of holes that must be cut out. The CL2 AFJ case from West Hyde is ideal for the purpose as the front panel is both removable and exactly to the correct dimensions.

The following is a suggested sequence of events for construction:

1. Assemble the printed circuit board.
2. Cut the holes in the front panel for the display, the LEDs and the flexible connecting strip for the keyboard. Do not forget to drill and countersink the holes for the spacers that will carry the printed circuit board on the back of the front panel. This will be clear from the illustration in figure 4. Take care to ensure that the holes line-up with those in the printed circuit board. When the front panel is prepared, the spacers can be fitted using counter-sunk screws. Care taken at this stage will handsomely repay the effort. It is not a bad idea to cover the inside on the front panel with a layer of insulating material to guard against the possibility of short circuits.
3. With great care, fit the self-adhesive front panel in place and apply a little pressure over all its surface.
4. Now it is time to screw the printed circuit board in position.
5. Finally the transformer and the NiCad cells can be fitted in the interior of the

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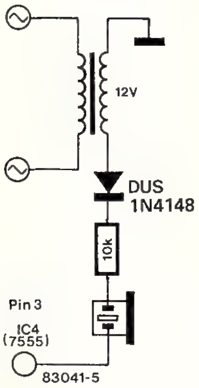


Figure 5. Fully monaural calibration is used to set the frequency of the emergency standby power supply. The only other requirement is one human ear!

cabinet. The relays or solid state switches can also be mounted now if it is intended that they are to live with the rest of the circuit.

If ordinary relays are to used it is recommended that an RC network consisting of a 100 Ω/1 W resistor in series with a 100 n/630 V is wired across their contacts to avoid interference caused by 'sparks'. The rear of the cabinet will also require a few holes made for the mains supply lead and the switching outputs.

Do not insert ICs 4 . . . 8 into their sockets until the construction of the printed circuit board is complete. The same goes for the emergency supply and R1 and D5. The voltage level on the −9 V supply will be incorrect when R1 and D5 are fitted and IC4 and IC7 are not.

When the board is ready connect the transformer, switch on, and check the voltage levels from the supply. The preset potentiometer P1 can now be calibrated (see the calibration chapter for this). If everything is as it should be, R1, D5 and the ICs can be fitted to the board.

Some finer points:

a. Mount the LEDs so that they do not quite touch the front panel when the board is fitted in position. The displays can be brought nearer the front panel by mounting them in two sockets in 'piggy-back' fashion under each display. Connections to the board by wires carrying the supplies and outputs to the relays and so on can best be made using printed circuit pins soldered to the track side of the board. This will allow them to be reached quite easily later on. The voltage regulator IC1 must be mounted in some convenient position to use the case as a heat sink. If this is not possible then a heatsink will be required. Be sure to use an insulating mica washer.

b. The position of the contact strip keyboard at the back of the front panel is shown in dotted lines in figure 2. This drawing can be used as a pattern when cutting the holes in the cabinet front panel. Remember to make an opening for the contact strip.

c. It may be found easier to cut the front panel to the exact size before fitting it in place on the cabinet front panel. Obviously a sharp knife will be needed for this purpose. Do not cut off more than 10 mm from the top or bottom edges and not more than 20 mm from the sides.

Calibration

The astable multivibrator (IC4) will always be synchronised to the mains frequency during normal operation. If an emergency standby supply is not to be used then calibration of P1 will not be necessary. Setting P1 to its mid position will be fine.

If, on the other hand, an emergency backup is fitted then IC4 must be calibrated to provide an output frequency of 50 Hz, even in the absence of a mains supply. Obviously this calibration will be a simple matter with the aid of a frequency counter. However, a reasonably accurate setting can be acheived without it. All that is required in the way of test equipment is an ordinary crystal earpiece or piezo tweeter.

It happens like this:

- For safety's sake remove all the ICs from the printed circuit board with the exception of IC4 and the voltage regulators.
- Disconnect the power from the mains.
- Connect the earpiece or tweeter as shown in figure 5.
- Connect the batteries or NiCads for the emergency supply.
- Rotate P1 until the tone from the earpiece is as pure as it is possible to get, without any obvious 'beat'.

That completes the calibration procedure! The batteries must again be disconnected before mounting the ICs on the board.

Final remarks

This last chapter could be entitled 'Quirks' because that is precisely what it is about. Not real problems, just peculiarities that we found with the prototype.

Here is the first. It may happen that the display goes off for some seconds when a lot of program entering is being carried out and the TIME key is pressed. This is quite normal and is due to the fact that when the processor is very busy it will tend to 'forget' about the display for a short period of time. The clock does in fact begin to run as soon as the TIME key is operated.

A second peculiarity. When checking switching times being stored in memory by displaying them, it is possible that the time displayed does not correspond to that being stored. There is one feasible explanation for this. The clock switched at the instant the time checks were being performed. In that case, it is certain that nothing has changed in the memory! The correct information can be displayed by first pressing the CLEAR key and then continue with the required procedure for checking stored switching times.

Last but not least. The display will flash for one full minute at 00.00 (except for Sunday at midnight). This was considered rather strange but it seems to be normal for the TMS 1601 so don't pay any attention to it!

You have written your own program. Now it is merely necessary to enter the program and run it. In many cases however, the bugs are having a field day. Where does one start with debugging? The first items to check are the contents of the accumulator, the X- and Y-register and the processor status register. This is usually the quickest way of finding possible errors.

P. Wild

junior program tester

a valuable aid in writing programs

The register check is not very complicated and is a great aid to all Junior Computer owners. In order to display the contents of the accumulator and of the X- and Y-register only a few commands are needed; these are contained in the program and ensure that the contents of the accumulator and of the X- and Y-register are displayed from left to right. A few commands are also contained in the program for displaying the processor status register. Something more is required, however. In addition to the software a small hardware change is needed; figure 1 shows the circuit. Since there is insufficient space on the display for hexadecimal representation of the processor status register contents, the flag statuses are displayed bit-by-bit (there is not much point in indicating the status of the individual flags in hexadecimal notation). The program loads the contents of the processor status register into port A. An 8-bit data latch, IC1, accepts the logic states of the individual flags and displays them using drivers N1 . . . N7 and LEDs D1 . . . D7.

The circuit of figure 1 should be constructed on an additional board which can then be plugged into the port connector when needed. The program to be tested is provided with a BRK command at a suitable point, and the BRK vector must point to the start of the following test program:

```
 85  FB       STA POINTH
 86  FA       STX POINTL
 84  F9       STY INH
 68           PLA          Fetch processor
                           status register and
                           load it into port A
 8D  80  1A   STA PAD
 A9  FF       LDA #FF
 8D  81  1A   STA PADD     Port A output
 8D  83  1A   STA PBDD     Port B output =
                           clock signal for
                           FF1 . . . FF7
/20  8E  1D   JSR SCANDS
 4C  XX  XX   JMP          Back to /
```

The only escape from the test program is via RST.

1

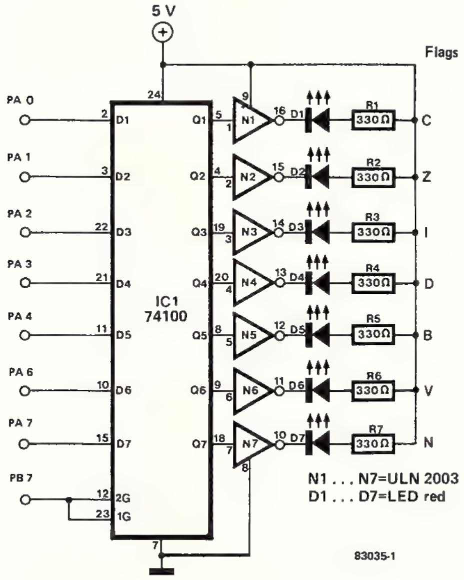
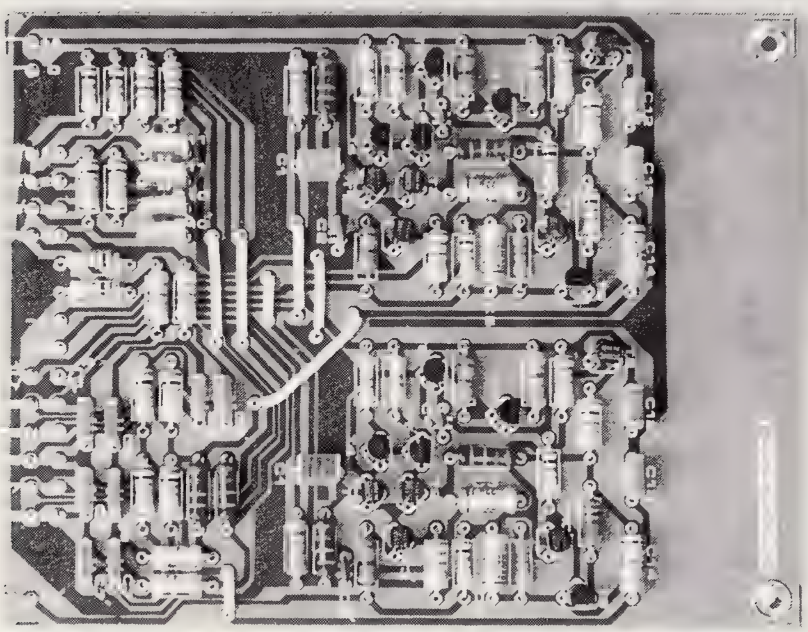


Figure 1. Two IC's, seven resistors and seven LEDs: the total hardware investment.

The end is in sight! We have now reached the final constructional article in the Prelude series: the printed circuit board for the tone control. This circuit is not entirely essential for a control amplifier but it can be useful. This is especially true if it has switchable turnover points for the filters. And (the height of sophistication!): a tone defeat switch, enabling the filter circuit to be taken out so that the tone controls have no effect on the signal.

(Part 3)

Prelude



tone control

The first question that demands an answer is: Why do we have a tone control for the Prelude? After all, it was stated at the outset that we would do our utmost to keep the 'processed' signal as pure as possible and now we are suddenly discussing tone controls. What have they to do with high quality reproduction? Not a lot! However, situations can arise where a tone control may prove rather useful. Of course, a tone control is superfluous if everything else is 100% OK from the record right through to the speakers. Unfortunately, the real world is something else and there is often a need for some subtle corrections in the frequency response.

A case in point is that of older records. A great many collections include records that date back ten or more years. These very often leave something to be desired in terms of quality and it is here that a tone control circuit becomes fairly important. We make no comment about the average quality of records bought today!

A second argument in favour of tone controls comes to light when that age-old topic of speakers-versus-rooms is broached. Very few listeners do not now realise that the acoustics of the room have a significant effect on the speaker system in use. Inadequacies can be compensated for by the educated use of the tone circuit. To a certain degree, a 'cost-effective' speaker can also be given a helping hand.

It is also true to say that not every listener's hearing is the same, especially if years are beginning to tell. We now have a situation where a tone control is very necessary. And let's not forget Mr Average, a member of the vast majority who likes to hear what he likes to hear – especially the bass! And what is wrong with that, may we ask?

When all is said and done then, we feel that most people would welcome the tone control circuit here. The added facility of the two switched turnover points for both the high and the low frequencies make it quite useful. The 'straight-wire' fanatics have the tone defeat switch to satisfy them. When operated this, as its name suggests, takes all the tone control elements out of circuit.

The tone control in detail

The complete circuit diagram of the tone control is shown in figure 1. This again follows the concept of the line and headphone amplifiers (T1 . . . T9). The detailed description of the amplifier circuit itself will therefore be found in the articles covering the line and headphone amplifiers (February and March 1983). A lightning trip through the circuit goes like this:

The input is fed to T1 which, together with T2, makes up a differential amplifier with a current mirror (T4 and T5) in its collector lines. The signal is then fed to the output stage consisting of T8 and T9 via the darlington pair, T6 and T7. This configuration provides considerable gain. The dc current setting of the differential amplifier is taken care of by T3, while T10 looks after the darlington (and therefore the output stage). These two transistors are connected as current sources. The input signal is fed to the base of T1 while the feedback arrives at the base of T2. Part of the tone control network is included in the feedback loop.

It is now time to take a little side-step into the tone control circuit because it is slightly different from that usually expected. The most frequently used tone control circuit is the Baxandall. This is an active circuit that makes use of the feedback loop of the amplifiers. Its principle of operation is illustrated in figure 2a. A frequency dependent potentiometer P forms the feedback loop of the amplifier: the input signal is present at one side of the potentiometer and the output signal at the other. If we take the impedance of the left part of the potentiometer as Z1 and the impedance of the right side as Z2, then the gain will be $\frac{Z2}{Z1}$. This means that the input and output signals will have the same value when the wiper of the potentiometer is in the mid position. It follows then that rotating P clockwise will increase the impedance of Z1 by the same amount

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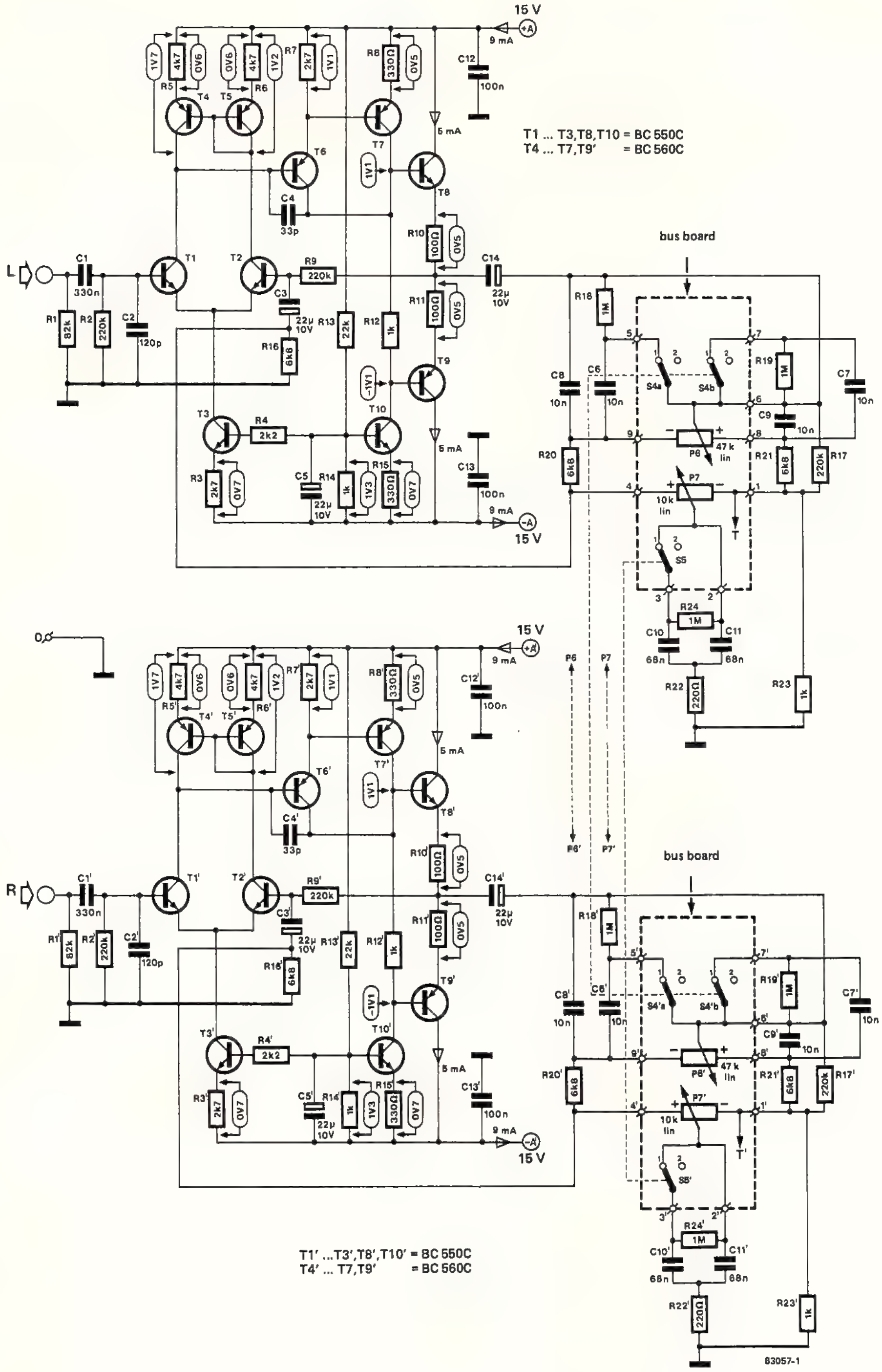
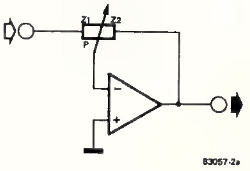


Figure 1. The circuit diagram of the tone control for the Prelude. The basis of the circuit is a high quality discrete opamp that has been used in other sections of the Prelude preamplifier.

2a



2b

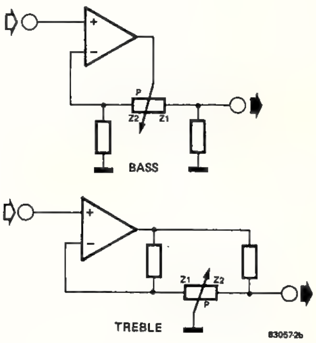


Figure 2. The usual configuration of a Baxandall tone control network is illustrated in figure 2a. The circuit in the Prelude is a modified form of this (figure 2b). The major difference is that the first requires a buffer stage and the second doesn't.

3

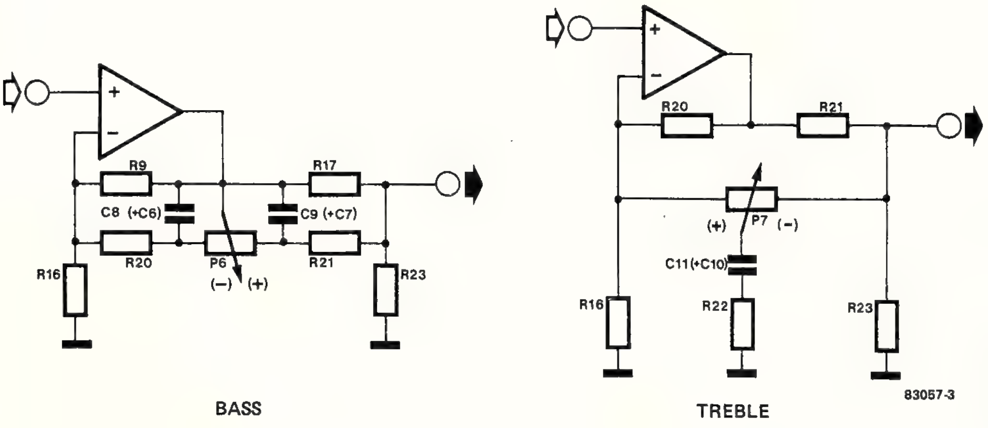
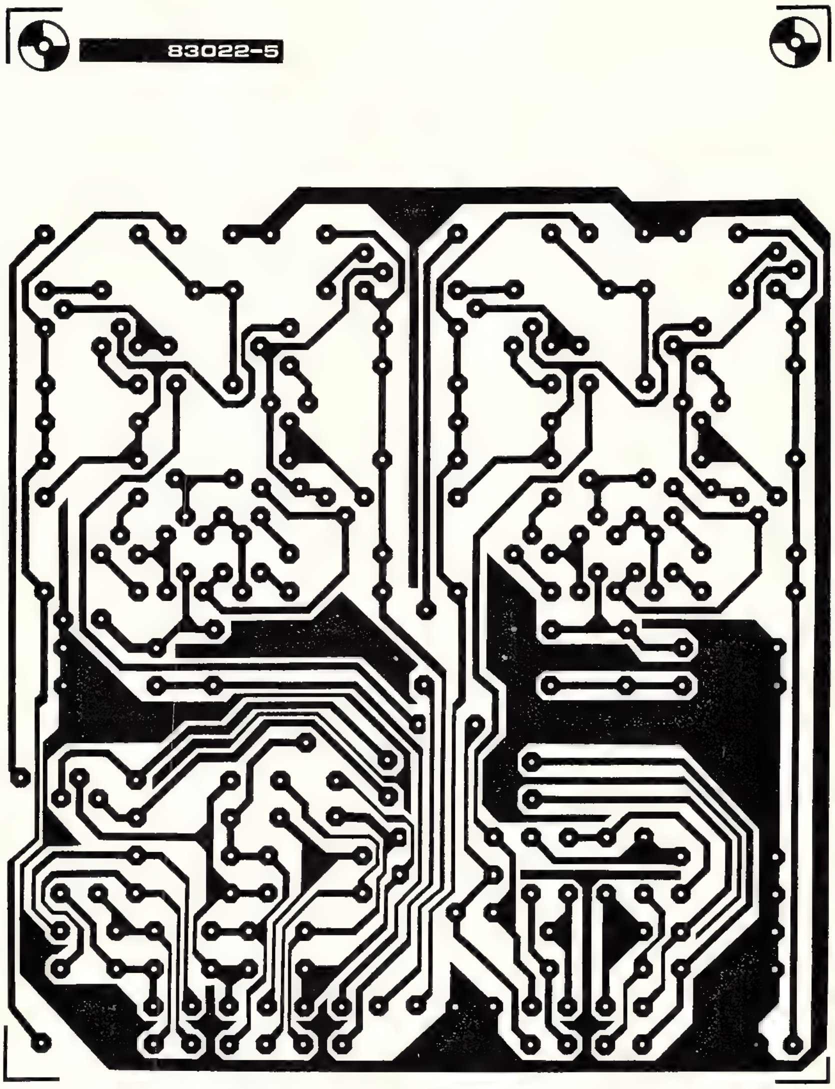


Figure 3. This figure shows those components that are included in the high and low frequency control circuits. The component numbers in brackets refer to the capacitors that are switched.

4



that Z2 decreases. Depending on the (capacitive or inductive) characteristic of P, a certain part of the frequency range will be amplified more. However, if the potentiometer is rotated in the opposite direction the amplification factor will be reduced. The overall tone control circuit must have a very low impedance in order to avoid any noise problems. This implies that a buffer stage must be employed at the input of the Baxandall tone control circuit. Considering the fact that a high quality buffer stage would require a lot of components, we opted for another circuit that needs only a single amplification stage.

Our solution to the problem is presented in figure 2b. This shows that the frequency dependent potentiometer is now placed behind the opamp. The operation of this circuit is practically identical to the Baxandall tone control. If the potentiometer is rotated so the value of Z1 increases and that of Z2 decreases, this would lower the amplification factor while the output attenuation would be higher. The reverse is of course true.

This circuit has one disadvantage when compared to the usual Baxandall configuration. The output must supply a slightly higher output voltage to compensate for the output attenuation. This could mean that the amplifier will start clipping at higher input signal levels but this problem will not occur if the presets at the input of the Prelude are correctly set.

The practical circuits for both the high and the low frequency tone controls are shown in figure 3. It will be noted that a number of components lead a 'double life'.

Back to the main circuit diagram of figure 1. The switched turnover points are provided by switches S4 (low frequencies, 400 Hz and 800 Hz) and S5 (high frequencies, 2 kHz and 4 kHz). Each switch changes the value of the frequency determining capacitors by adding a further capacitor in parallel.

The tone defeat switch, S12, is not shown in the circuit diagram of the tone controls. Since it has nothing to do with the tone controls it appears on the circuit diagram of the bus board. For the detailed description of this board refer to the March 1983 issue. The tone defeat switch does just that by selecting either the input or output of the tone control circuit. If the tone defeat switch is 'in', the input of the tone control circuit is grounded and is therefore prevented from supplying an output signal.

Construction

The printed circuit board for the tone control module is shown in figure 4. There are a number of points that require particular attention during construction.

The switches S4 and S5 and the stereo

Parts list

Resistors:
R1,R1' = 82 k
R2,R2',R9,R9',R17, R17' = 220 k
R3,R3',R7,R7' = 2k7
R4,R4' = 2k2
R5,R5',R6,R6' = 4k7
R8,R8',R15,R15' = 330 Ω
R10,R10',R11, R11' = 100 Ω
R12,R12',R14,R14',R16, R16', R23,R23' = 1 k
R13,R13' = 22 k
R18,R18',R19,R19',R24, R24' = 1 M
R20,R20',R21,R21' = 6k8
R22,R22' = 220 Ω
P6,P6' = 50 k (47 k) lin. stereo potentiometer*
P7,P7' = 10 k lin. stereo potentiometer*

Capacitors:
C1,C1' = 330 n
C2,C2' = 120 p
C3,C3',C5,C5',C14, C14' = 22 μ/10 V
C4,C4' = 33 p
C6 . . . C9,C6' . . . . C9' = 10 n
C10,C10',C11,C11' = 68 n
C12,C12',C13, C13' = 100 n

Semiconductors:
T1,T1',T2,T2',T3,T3', T8,T8',T10, T10' = BC 550C
T4 . . . T7,T4' . . . T7', T9,T9' = BC 560C

Miscellaneous:
S4 = 4-pole, 2-way*
S5 = 2-pole, 2-way*

* mounted on bus board

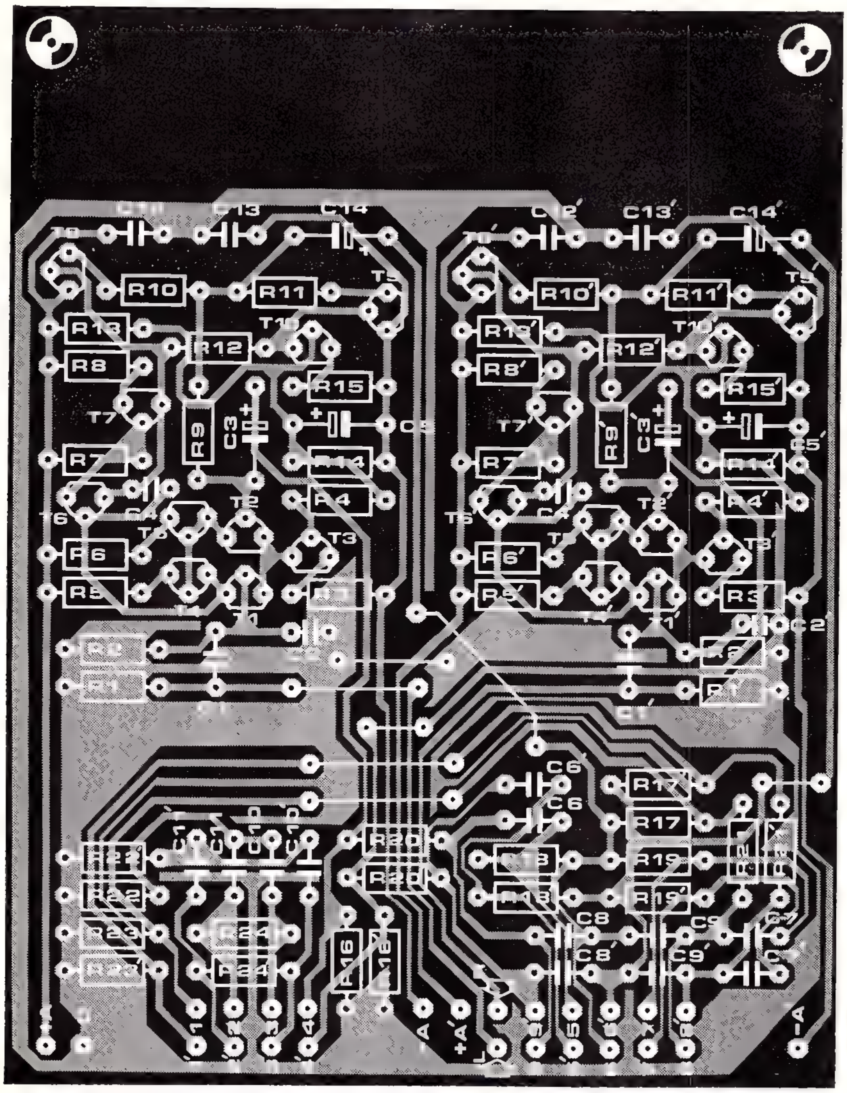


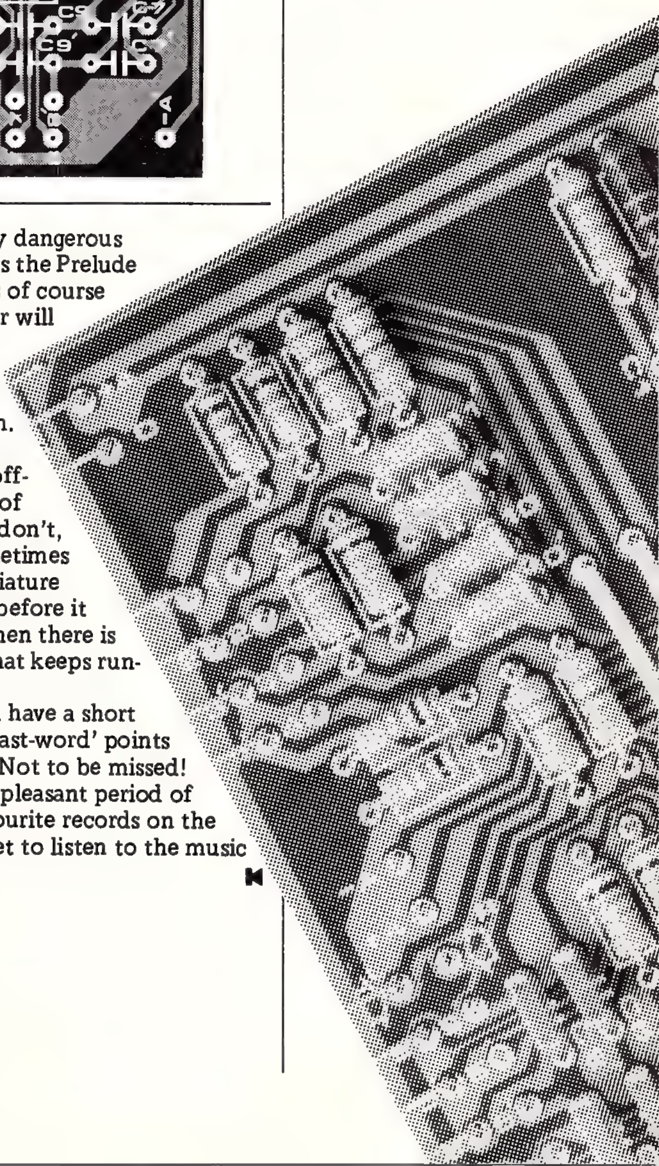
Figure 4. The printed circuit board of the tone control stage. There are two rows of connecting points that must be connected to the bus board by short wire links.

potentiometers P6/P6' and P7/P7' are connected directly to the bus board with the aid of short lengths of wire. The next step requires a little more patience. There are two sets of connecting links between this printed circuit board and the bus board. The row nearest the edge of the board are connected on the component side of the board while the row farthest from the edge of the board are connected on the track side. Short lengths of wire (resistor offcuts!) are soldered in place so that they stick-out from their allocated side of the board. Those on the component side can be bent to run parallel with the board. The same will happen to those on the track side but they must first be covered with a short length of sleeving to prevent any nasties happening. Take note that the component side of the tone control board faces towards the right when looking at the front of the Prelude. A little patience is needed when fitting the 'edge connector' into the mother board to ensure that problems do not arise.

The Prelude is now complete and testing can begin. If visitors are present – prepare to act nonchalant! A signal source will of course be required and a tuner will be suitable for this purpose. An amplifier and a pair of speakers would also be convenient! After checking to see that all switches and controls are as they should be – just switch on!

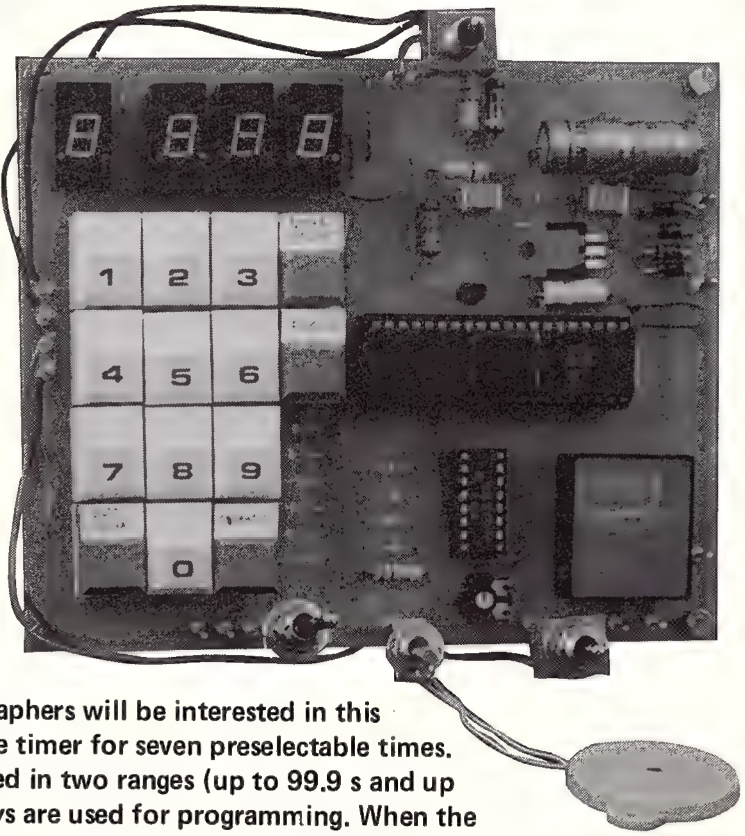
This is an extremely dangerous moment! As soon as the Prelude bursts into life – as of course it will – your visitor will suddenly realise that an electronics genius is standing right in front of him. Without hesitation, he will proceed to offload an assortment of tape recorders that don't, televisions that sometimes do and a micro-miniature radio that was fine before it 'fell' in the bath! Then there is this battery razor that keeps running down and . . .

Next month we will have a short article concerning 'last-word' points of note and things! Not to be missed! Meanwhile, enjoy a pleasant period of trying out your favourite records on the Prelude. Don't forget to listen to the music sometimes . . .



programmable darkroom timer

convenient IC allows simple construction



Many amateur photographers will be interested in this circuit: a programmable timer for seven preselectable times. The time can be adjusted in two ranges (up to 99.9 s and up to 999 s). Fourteen keys are used for programming. When the start key is pressed, the time countdown can be observed on the display. The preset value then reappears on the display. There is therefore no need for repeated entering of the proper exposure time.

The advantages of a programmable darkroom timer are well known. Most manufacturers now try to make their equipment as simple to use as possible. An LED display and programming via a keyboard have almost become standard features. Clearly, however, these features are not inexpensive. Elektor has therefore taken the opportunity here to present this circuit of a darkroom timer using a special IC as a low-cost alternative to commercially available units. A printed circuit board has also been developed, thus allowing many amateur photographers to meet their requirements at last.

The timer IC: WD 55

Since the circuit of figure 1 chiefly consists of timer IC WD 55, we shall examine the characteristics of this IC in some detail. The manufacturers describe their product as a versatile timer module which can replace all mechanical timers in control engineering. Without wishing to dispense free publicity, we can nevertheless say that this IC is ideally suited to our application.

The device is a 4-bit microprocessor with on-chip (preprogrammed) ROM. In other words, all the characteristics described in the following are already provided, except for a few which are selected externally. The processor can operate in two modes: as a key-programmable timer/controller, the internal RAM is used as a data memory and a 4-digit, 7-segment display provides the readout. In its other mode, the processor operates as an on/off timer: switches or diodes serve as data memory and data readout; there is therefore no need for a display.

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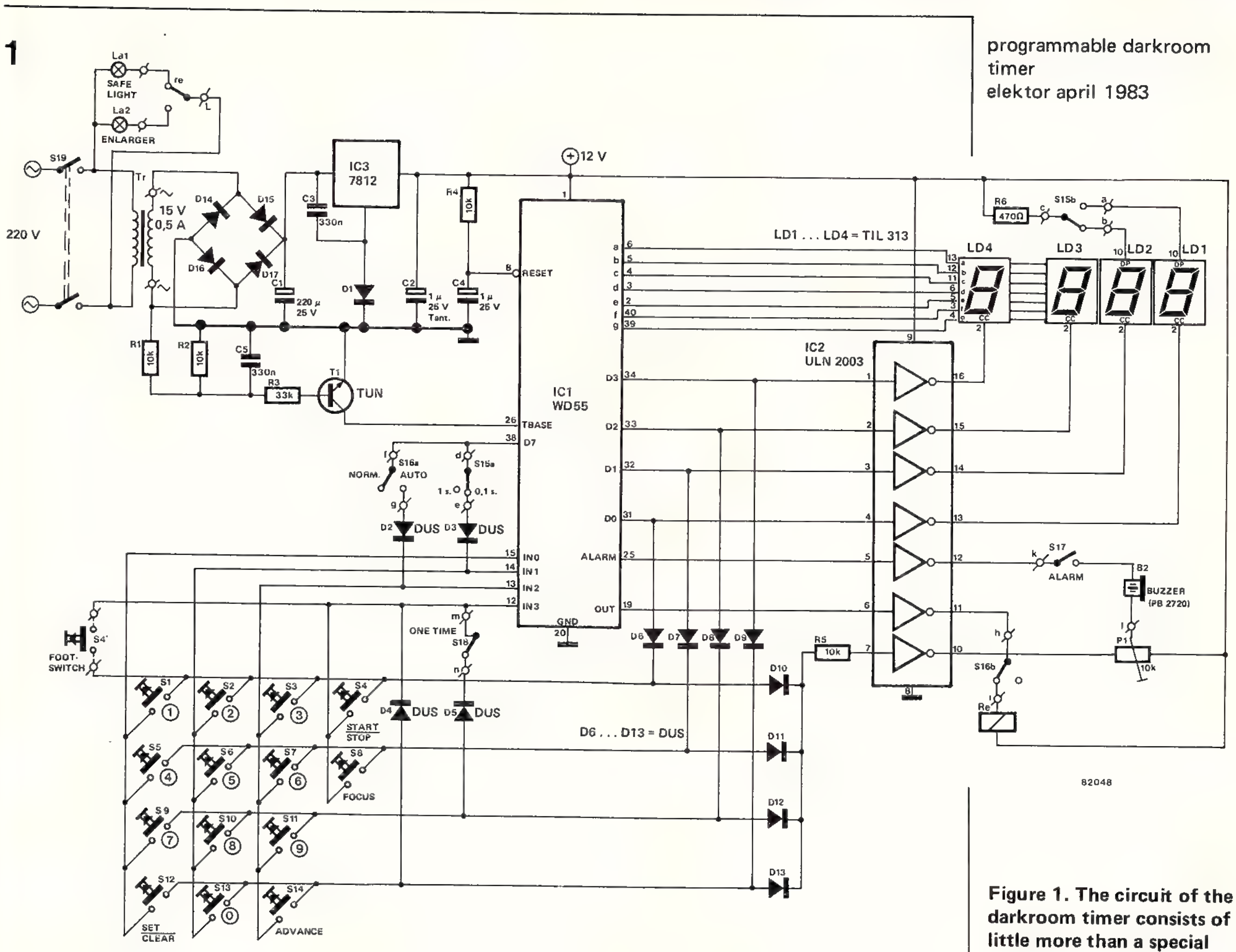

Figure 1. The circuit of the darkroom timer consists of little more than a special timer IC. A keyboard is used for programming.

Incidentally, the principle of such a timer was presented in the 'wide range darkroom timer' in the October 1981 issue. The two modes are selected by means of a diode between pin 38 and pin 15 of the IC. If the diode is omitted, as is the case in this application, the processor operates as a key-programmable timer/sequence switch. In this mode a keyboard and a 4-digit, 7-segment display are required. The processor can then be utilised as an ideal darkroom timer. Figure 1 shows the complete circuit.

Programming

The timer is programmed via a keyboard arranged in a 4 x 4 matrix. Table 1 shows the functions assigned to the individual keys. The cross-hatched boxes show that certain functions are or can be permanently selected with these connections.

Fourteen keys are needed to make the timer freely programmable. Each keystroke is acknowledged by a beep from the piezo-electric buzzer. Thus it is also possible to use a sensor-type, touch-keyboard. However, one imperfection is associated with this key-actuated operation: the operation is only initiated when the key is released (except for the stop-function). But one quickly becomes accustomed to this.

The key functions in detail:

ADVANCE: this key is used to step through the memory (RAM) stages. There are seven stages altogether, allowing several different times to be programmed. With each key-stroke, the memory number on the extreme

Table 1

pin	15	14	13	12
31	1	2	3	START/ STOP
32	4	5	6	FOCUS
33	7	8	9	ONE TIME
34	SET/ CLEAR	0	ADVANCE	50 Hz
38		0,1 s/ 1 s	NORM/ AUTO	

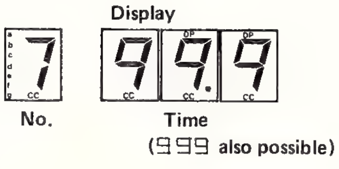

Table 1. Functions of the timer IC when used as a darkroom timer.

Outputs:
pin 19 – relay
pin 25 – piezo-electric buzzer

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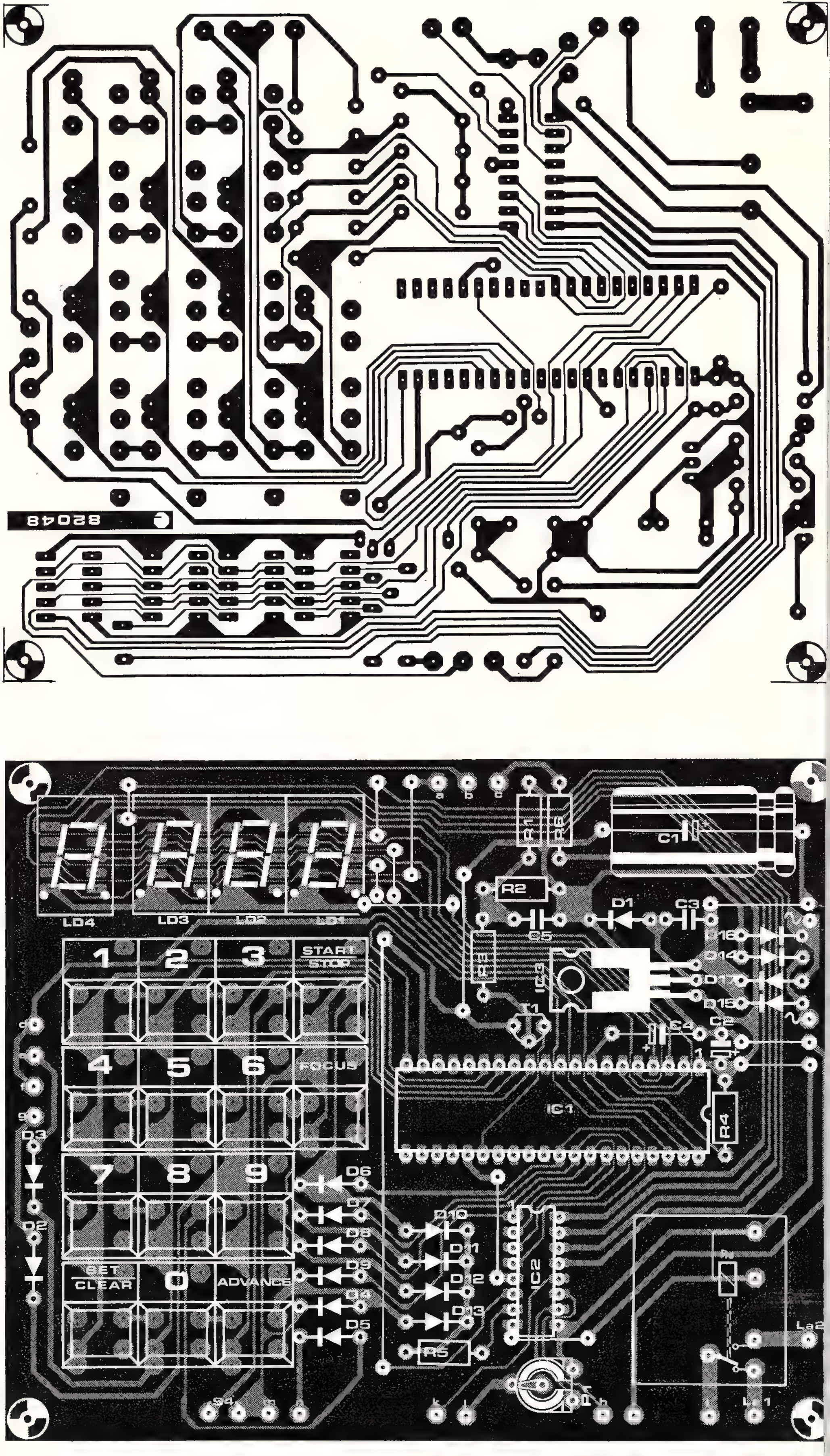


Parts list

Resistors:
R1,R2,R4,R5 = 10 k
R3 = 33 k
R6 = 470 Ω
P1 = 10 k preset

Capacitors:
C1 = 220 µ/25 V
C2 = 1 µ/25 V tantalum
C3,C5 = 330 n
C4 = 1 µ/25 V

Semiconductors:
D1 . . . D13 = DUS
D14 . . . D17 = 1N4001
LD1 . . . LD4 = TIL 313 (common cathode)
T1 = TUN
IC1 = WD-55 Pronto Electronics (01-599-3041)
IC2 = ULN 2003
IC3 = 7812

Miscellaneous:
Tr = mains transformer 15 V/0.5 A sec.
S1 . . . S14 = Digitast SR
S15,S16 = double-pole changeover switch
S17,S18 = single-pole switch
S19 = double-pole mains switch
Bz = piezo-electric buzzer (e.g. PB 2720)
Re = 12 V Siemens pcb relay V23027-A0002 (electrovalue)

Figure 2. All the components of the darkroom timer can be mounted on this p.c. board (except the mains transformer, piezo-electric buzzer and lamps).

left of the display (LD4) is incremented by 1. Simultaneously the memory contents appear on the three right-hand positions of the display (LD1 . . . LD3). The most significant position is displayed by LD3. A '7' at LD4 is followed by a '1' when the key is pressed.

SET/CLEAR: pressing this key prepares the processor for data input into the memory via the numeric keys '0' . . . '9'. The display is set to '000'. The entered data are displayed step-by-step from right to left. If a numeric key is pressed for the fourth time, this value appears in LD1 and so on. Entry is terminated by pressing any non-numeric key. The display readout is automatically stored and there is therefore no need for an ENTER or DATA STORE key. Protection against incorrect entries is provided by the fact that the processor only responds to a numeric key if the SET/CLEAR key has previously been pressed.

FOCUS: this key can be used to switch the relay on and off at the output of the processor. This facility makes it possible to adjust the enlarger before starting the exposure. The relay remains in that condition until this key is pressed again, or until the exposure is started by pressing the START key.

START/STOP: as its name implies, this key is used to start or stop the exposure. Countdown of the displayed time begins when the key is released. An exposure in progress is immediately stopped by pressing this key. Care should be taken to press the key only briefly, otherwise the process starts again after a certain delay. The relay operates and the program is sequenced to the next programmed time. The START/STOP key can also be bridged with a footswitch, and is the only key which is operational when an exposure is in progress.
Numeric keys 0 . . . 9: data can be entered with these keys. The SET/CLEAR key must previously have been pressed. The entered data are shown on the display from right to left. The number just entered is shifted across the display from right to left and overwrites the previous number. The keys can be pressed any number of times. However, only the last three entries are displayed and stored. Unless the SET/CLEAR key has first been pressed, pressing the numeric keys will have no effect.

Apart from this free programming using the keys described, some functions can be permanently selected using switches.
Diode D4 sets the internal timebase to a clock frequency of 50 Hz.

Diode D5 is switched on with switch S18 if the processor is only to process *one time*. When this time has elapsed, therefore, sequencing does not take place to the next programmed time. Instead, LD4 continuously displays a '1' and when the time has elapsed, LD1 . . . LD3 display the previously selected time once again. The ADVANCE key is not operational in this case.
Via S15a, diode D3 establishes whether or not the time can be programmed in the 1 s or in the 0.1 s scale. This results in a display range of either 1 . . . 999 s or 0.1 . . . 99.9 s. S15b switches over the decimal point.
Via S16a, diode D2 establishes whether the programmed times are to run automatically or manually. Automatic means that when the start key is pressed, times 1 . . . 7 will run successively. This automatic run only stops when the seventh time has elapsed. The first time is then displayed again and the keyboard is operational once more. In this case the relay is switched off with S16b.
An example of an application using this mode is its use as a process timer in a photographic laboratory. If one selects a time of 10 min at position 5, 0.5 min at position 6, and 3 min at position 7, the developer bath, the stop bath and fixer bath for the film can be timed in that sequence starting with time 5. The times should always be arranged so that the last time to be programmed is at position 7. Otherwise the timer continues to run and one can lose track of the times to be monitored.
The buzzer emits a beep 10 s before a programmed time elapses. When the time has elapsed, the buzzer beeps twice.

Darkroom timer

The description of the programming already contains all the information needed to operate the darkroom timer. The additional hardware is shown in figure 1. This circuit consists of little more than the timer IC, keyboard, display, diodes and switches for fixed programming. IC1 can directly drive the segments of the display. The cathodes of the 7-segment readouts are driven via IC2. Of the remaining three drivers in IC2, two control a piezo-electric buzzer (this can be switched off with S17, and P1 is used to adjust its volume) and one drives the relay for switching the two lamps (enlarger and darkroom lighting). Display outputs D0 . . . D3 are connected to the keyboard via diodes and are also routed to the buzzer in an OR operation. This results in a beep with each keystroke.
R4 and C4 at pin 8 of IC1 ensure that the display is automatically reset to '1 000' when the operating voltage is switched on. The 50 Hz signal for the timebase reaches the timer IC via R1 . . . R3, C5 and T1. The power supply with voltage regulator IC3 provides the 12 V operating voltage. Although IC3 becomes very warm, it does not require a heatsink. After insertion, this IC is bent so that the metal surface faces upwards.
The printed circuit board accepts almost the entire circuit (figure 2). The only external connections required are from the transformer and buzzer to the p.c.b. and from the relay contact to the lamps. If desired, a footswitch can also be connected in parallel with S4. ◀

Literature:
WD-55 Industrial Timer/Controller, Western Digital Corporation

The 'Talking clock' presented by Elektor in the June 1982 issue only speaks when instructed to do so. In order to hear the time, it is therefore necessary to press the talk button. The following extension makes the circuit more convenient and the time is announced every hour.

talking-clock extension

Table 1. Minutes ones

Digit	Signal M.O. . . a	b	e	f	g
0	1	1	1	1	0
1	0	1	0	0	0
2	1	1	1	0	1
3	1	1	0	0	1
4	0	1	0	1	1
5	1	0	0	1	1
6	1	0	1	1	1
7	1	1	0	0	0
8	1	1	1	1	1
9	1	1	0	1	1

Table 2. Minutes tens

Digit	Signal M.T. . . d	e	f
0	1	1	1
1	0	0	0
2	1	1	0
3	1	0	0
4	0	0	1
5	1	0	1

E.A.J. Bogers

The speech generator IC (IC1 in figure 4 of the Elektor June 1982 issue) receives its time information via flip/flops IC2 . . . IC5. This is the information for the minutes and minute tens, hours and hour tens. The information for the minutes and minute tens which are present at the control inputs of the speech generator IC are listed in tables 1 and 2. At every full hour (at XX.00) the minutes information M.O.f and M.O.g is '1-0' and at M.T.e and M.T.f it is '1-1'. These logic signals only appear in this combination once in the tables. It is therefore merely necessary to start the speech generator IC with this information combination.

The signals required are designated as follows in the circuit diagram (figure 4 of June 1982 issue): 'H' for M.T.f, 'G' for M.T.e, 'E' for M.O.f and the inverted signal 'A' for M.O.g. The inverted signal 'A' is available at pin 9 of IC5. The four signals are subjected to a logic operation via the AND-gate of figure 1. The output of gate N1 is a logic 1 when the minutes indicate '00'. The RC network between gates N1 and N2 suppresses the small interfering pulses created by the IRQ routine of the clock. As a result of the feedback provided by R3, gate N2 acts as a Schmitt trigger.

Should this more talkative clock become irritating, it can be silenced by setting switch S1 to position 'b'. The connecting points G, H, E, pin 9 of IC5, ALARM, +5 V and 0 V in figure 1 are connected to the corresponding points on the speech board (for example, +5 V to the positive terminal of C13).

One minor imperfection must be taken into account. The time is announced if the date is queried on the hour and the clock is then switched back to the time display. As soon as the display indicates XX.00 again, the automatic time announcement becomes operational. The adjusting of switching times can also result in time announcements. In order to suppress this, switch S1 should simply be set to position 'b'. ◆

1

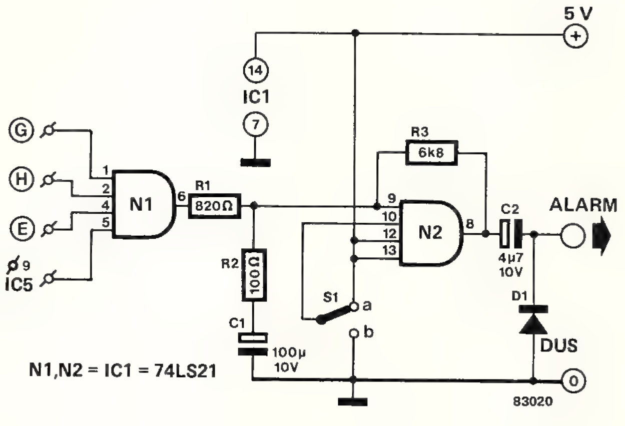
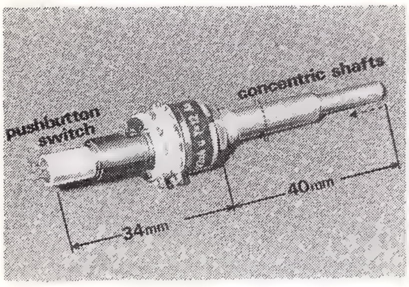


Figure 1. This is the circuit for automatic hourly announcements of the time.

Multiminiswitch

Adding to the wide range of applications already in existance for rotary wafer switches, N.S.F. have taken a miniature rotary wafer switch and an ultra-miniature pushbutton switch, forming them into one dual-action component.
Basing this arrangement upon a concentric shaft, the outer controls the rotary movement and activation of a model MX, 30° indexing switch whilst the inner provides the linear movement necessary to operate the UMO momentary action pushbutton switch.



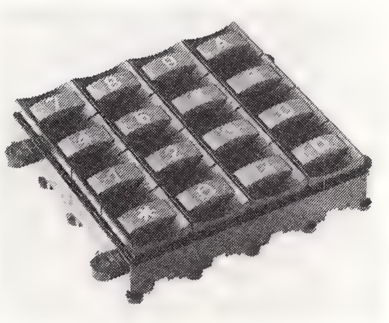
The length dimension from the mounting face to the end of the pushbutton body is 34 mm and the diameter of the MX wafer is a mere 17 mm.
Applications for such a versatile dual-action switch includes the control of electronic latching circuits.

N.S.F. Limited,
Keighley,
Yorkshire BD1 5EF.
Telephone: 05352.61144

(2562 M)

MEC 75 — mini super switch

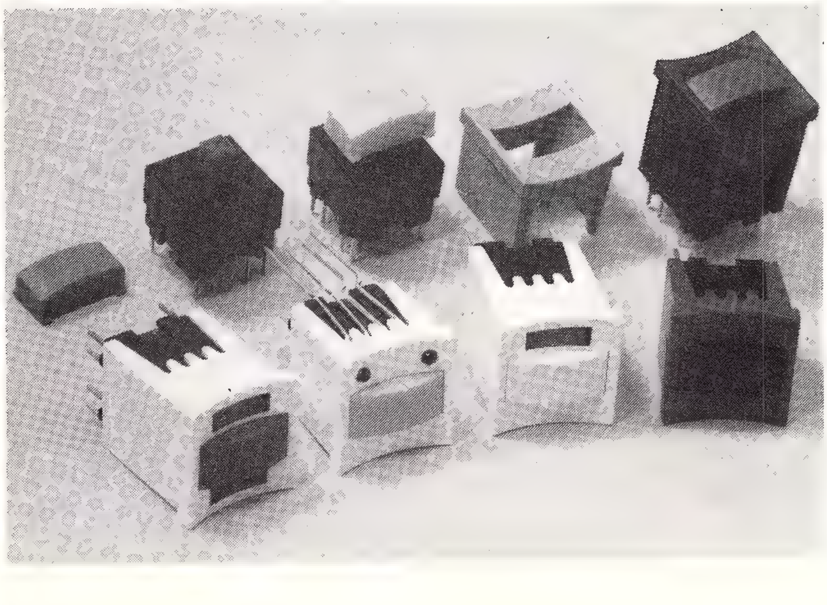
The MEC 75 switch module has been developed in order to provide a printed circuit board mounting switching module with a very high degree of versatility. In a package measuring only 15 mm x 15 mm no less than 6 different contact functions are possible simply by selecting the appropriate pins with the printed circuit board design. The MEC 75 is designed to fit the standard 0.1 inch grid pattern and is available in both momentary and alternate key action, both with tactile feel.



The Unimec keycap system again allows maximum versatility by providing buttons and bezels for the switch. Bezels can accomodate 1 or 2 high brightness 'pin-head', or rectangular bar LEDs, or without LED illumination as desired. The bezels are designed to allow for maximum mounting density in any configuration, using a 0.1 inch grid printed circuit board. Particular attention has been paid to the aesthetic design of the keycap and bezel combination and they are available in 10 attractive colours as standard.
The Vario-Support system is a variable mounting frame that enables the switch range to be panel mounted and eliminates the necessity of a printed circuit board. The Vario-Support system is available in any cell combination from 1 x 1 up to a 10 x 10 matrix.

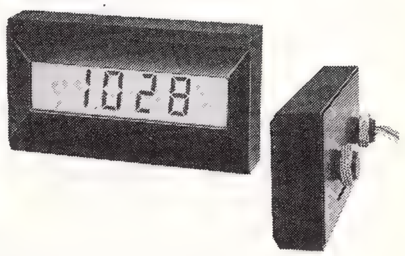
MEC 75,
54 Poplar Grove,
Maidstone,
Kent ME16 0AN.
Telephone: 0622 674947.

(2618 M)



Slimline Counter

Instant installation, regardless of voltage, is available with the latest electronic counter developed by Trumeter. Their new slimline counter is a universal totalising counter, which is only 16 mm thick and is ready for surface mounting, requiring only two small panel mounting holes. It has flying lead connections and, without adjustment, is suitable for a supply voltage range from 6 V DC up to 240 V AC, using a battery or mains supply.



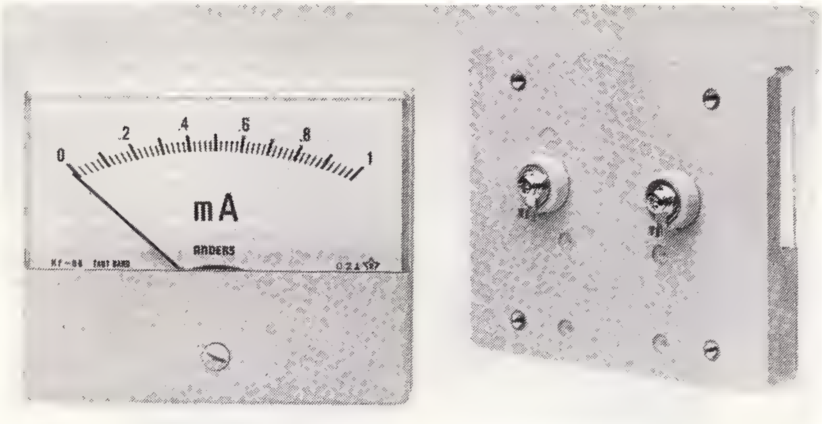
Clearly readable 12 mm high figures read up to 19999 and the whole unit measures only 43 mm high by 79 mm across and 16 mm deep. The casing will cover most existing panel cut outs and the counter is the ideal immediate replacement counter in control panels etc.
Count rate is up to 50 counts per second and the counter has high noise immunity CMOS logic. Operation is entirely noiseless and the LCD display is easily readable in embient light conditions.

Trumeter Company Ltd.,
Milltown Street,
Radcliffe,
Manchester M26 9NX.
Telephone: 061 724.6311. (2617 M)

'Flat' analogue panel meters

The new Tableau series announced by Anders Electronics Limited represents a fundamental re-think of analogue panel meter design. Not just a cosmetic alternative to traditional design, but a major change of approach — 'flat'meters *without* barrels.
To accommodate the size of traditional movements, virtually all previous panel meter case designs have included a rear barrel projection. The resulting complexities of a panel cut-out and the restrictions imposed by the intrusion of the barrel into the equipment interior have confronted design and production engineers over the years. By starting with a completely new movement design, the Tableau series avoids these disadvantages.
At the heart of the meter is a new ultra-thin 'sandwich' type moving coil movement. Built around a rugged taut-band suspension, this movement is said to meet or exceed the performance of most earlier designs and will withstand shock testing at 200 G. The natural low-friction properties of the taut-band approach leads to an overall linearity better than 1.5%. Standard sensitivities are from 100 μA

market



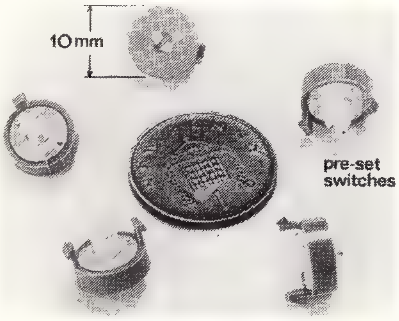
upwards and special ranges or scales are available on request.

The slim style case is just 14 mm thick and has a flat back surface, except for two terminals which serve as mounting studs and electrical inputs. Only two 10 mm diameter clearance holes are needed in the host panel to accommodate the terminals, which are electrically isolated from the panel. The Tableau series is initially available in three sizes; 49 mm square, 68 x 59 mm and 88 x 74 mm; having scale lengths of 34, 46 and 63 mm respectively.

Anders Electronics Ltd.,
48-56 Bayham Place,
London NW1 0EU.
Telephone: 01 387.9092. (2622 M)

Tiny rotary pre-set switch

The N.S.F. rotary pre-set switch is a compact, switchable link for snap mounting into printed circuit boards and operated by a standard 3 mm screwdriver. The housing size is only 10 mm dia. x 3.5 deep. The design enables actuation from either end of the rotor thus affording equipment designers a high degree of flexibility, especially where operation is from outside the equipment via an access hole in the casing. Two and three position models are available rated at 100 mA 50 V.



N.S.F. Limited,
Keighley,
Yorkshire, BD21 5EF.
Telephone: 0535.61144. (2626 M)

New power plug helps computers

Microcomputers suffering from amnesia need no longer be terminal cases!

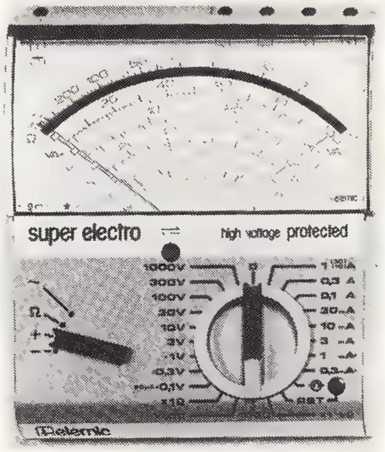
Spikes and holes in the domestic mains electricity supply (caused by switching off and switching on electrical equipment) can create havoc for microprocessor users — at worst, a complete crash, at best, a corruption of vital data.

To prevent downtime, reprogramming and to enhance the microcomputer's reliability, Power International's 'PLUG' — a neatly packaged RFI filter and transient suppressor of innovative design contained in a modified 13 amp plug case — effectively absorbs spikes in the power line and reduces their voltage to a tolerably safe level. As a total cost of $ 15.50 (including post, packing and VAT) the treatment ensures a healthy and happy computer at a very low cost.

Power International Ltd.,
2A Isambard Brunel Road,
Portsmouth,
Hants.
Telephone: 0705.756715. (2623 M)

High protection analogue multimeter

The 'Super Electro' Analogue Multimeter from Elemic of Italy offers superb styling and presentation combined with wide-ranging specifications in 57 ranges and features 50,000 V protection on all ranges. With voltage measurements to 1000 V (DC and AC) and current to 30 A (DC and AC) together with resistance and capacitance ranges, the 'Super Electro' also provides phase sequence detection for three phase systems and a mains and insulation tester. Based on a high precision, moving coil microammeter, the 'Super Electro' has coloured scales, an anti-parallax mirror and is complete with high quality lined protective case, fused test leads and a years guarantee. With 20 KΩ/V sensitivity and DC accuracy of 1.5% f.s.d., the 'Super Electro' offers exceptional specifications for £ 39,95 (+ VAT).



Black Star Ltd.,
9A Crown Street,
St. Ives,
Huntingdon,
Cambs PE17 4EB.
Telephone: 0480 62440. (2619 M)

Solenoid operated cassette mechanism

In deference to many requests from both home computer enthusiasts and professional data logging equipment manufacturers for a low cost DC controllable cassette mechanism, Ambit is launching a range of such mechanisms at the forthcoming All Electronics Show. The illustrated mechanism, is the AMBTN-3600, and can be supplied with a variety of heads to suit the end user application. The

market

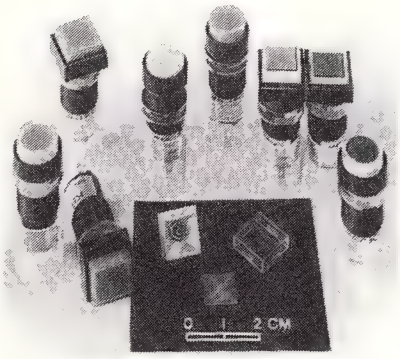
standard version is equipped with a stereo record/playback and erase head, although a wide range of combined record/replay heads are also available. Motor operation is from 12 V DC, with less than 0.08% RMS wow and flutter, with the record and playback specification largely determined by the heads selected and the drive circuitry provided. Ambit also offers a range of multi-capstan, multi-motor decks for high performance applications.

Ambit International,
200 North Service Road,
Brentwood,
Essex CM14 4SG. (2620 M)

Small illuminated pushbutton switches

A new range of small illuminated pushbutton switches and matching indicators is now available from N.S.F.

Single and double pole, double throw models are available with momentary or push-push actuation. The cylindrical housing measures 12 mm. dia x 24.7 mm from the mounting face, while the buttons are either 14 mm square with an 11.6 illuminated area or 14 mm dia. with an 11.6 dia. illuminated area. Illuminated models are available for either incandescent lamps or LED lamps with single element or double (including an IC chip), in red, yellow and green.

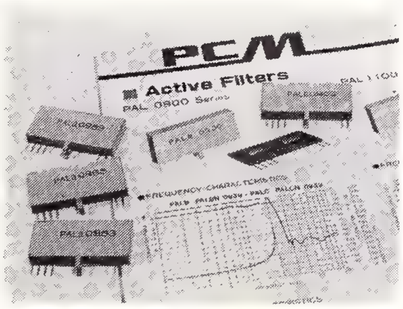


Normal colour coding of actuators is based upon 5 colours — red, yellow, green, blue and white which can be illuminated with an incandescent lamp. But combinations of red, green or yellow LED with differing filter can provide a wide variety of visual effects e.g. a single element red LED when used with a yellow diffusing cap produces a light brown effect.

N.S.F. Limited,
Keighley,
Yorkshire BD21 5EF.
Telephone: 0535.61144. (2627 M)

Thick film filters

Toko have introduced a range of 20 kHz low pass active filters, specifically for the digital audio market: the PAL 0900 series. The imminent arrival of the Digital Audio Disk has focussed much attention on the A/D and D/A designs required, but the low pass filter is probably one of the most critical points from the serious 'hifi' listener's point of view — since the perfection of the PCM process can be completely squandered at the simple LPF stage if the phase response is not optimised. Toko's thick-film low pass filters are available with a variety of terminating impedances, all with carefully optimised group delay, and with stopband attenuations up to −95 dB. Samples, data and applications advice is available from Ambit.

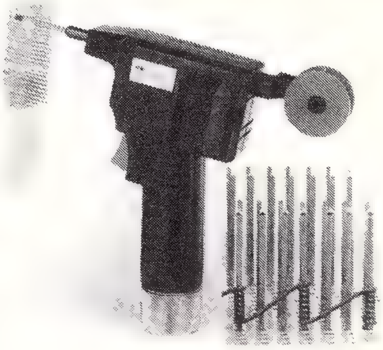


Ambit International,
200 North Service Road,
Brentwood,
Essex. CM14 4SG. (2628 M)

Battery powered wire wrap tool

OK have introduced a battery powered version of the Just Wrap tool, the BJW-3. In the patented Just Wrap process, a specially designed bit compresses insulated wire against the wrap post so that the post edge cuts through the insulation and makes reliable contact with the wire conductor. This allows the user to wrap directly from a wire reel or spool without precutting and prestripping, and makes it possible to wire continuous strings across any number of points with a single continuous insulated wire. The string may be ended at any point with a built in cut-off mechanism. The new BJW-3 is powered by two rechargeable batteries and features a rugged ABS housing and hardened steel components for performance and durability.

It comes complete with a specially designed bit and sleeve, and a 100 ft (30 m) spool of 30 AWG (0.25 mm) wire. Refill spools are available in 100 ft (30 m) lengths and in 4 colours, blue, red, white and yellow.

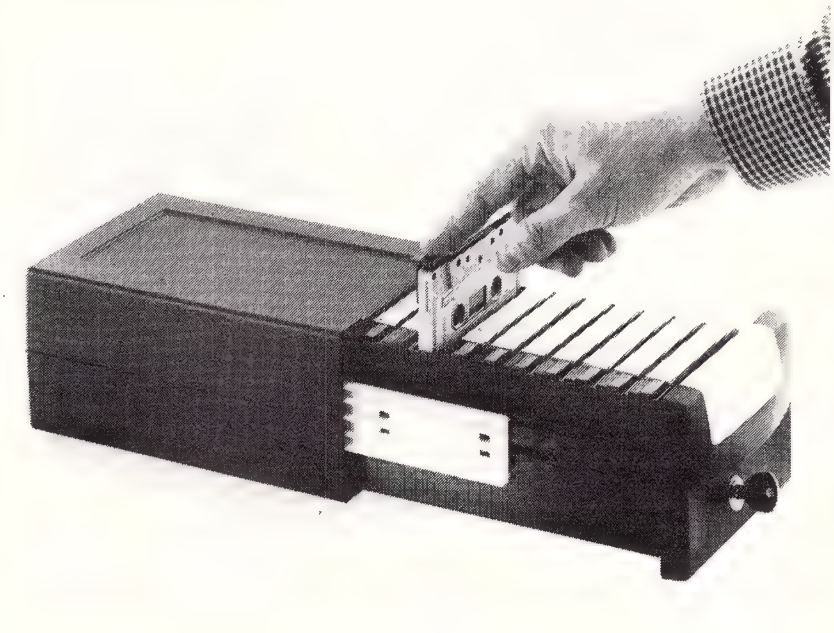


OK Machine & Tool (UK) Ltd.,
Dutton Lane,
Eastleigh,
Hants, S05 4AA.
Telephone: 0703.610944. (2625 M)

Safe Storage for Data Cassettes

The new Fischer C Box Drawer Unit has been specially designed for the owners of personal computers who are looking for safe and easily accessible storage facilities for their data cassettes that contain long term information — or games. The cassette rests in a spring loaded C Box that opens at the touch of a button and incorporates splined hubs to prevent slackening of the tape. Ten interlocked, individual C Boxes with easy-change labels are securely housed in this compact drawer unit that stacks neatly on shelves or next to the VDU. Two designs available: Standard and de luxe (lockable). Available from sole importers at £ 17.50 and £ 19.50 incl. VAT and p & p.

Artur Fischer (UK) Limited,
25 Newtown Road,
Marlow,
Bucks. SL7 1JY.
Telephone: 06284.72882. (2616 M)



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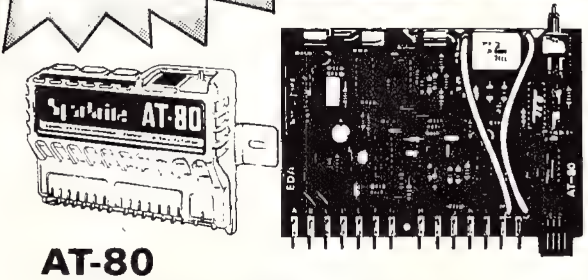

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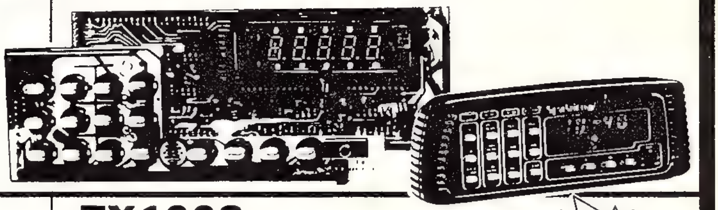

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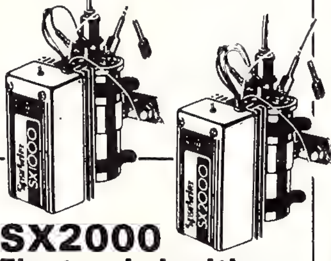

TX1002

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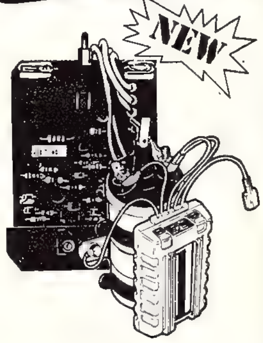

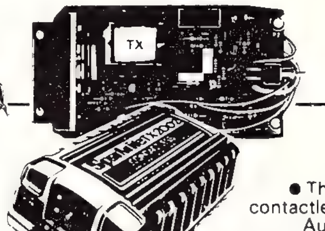

TX2002

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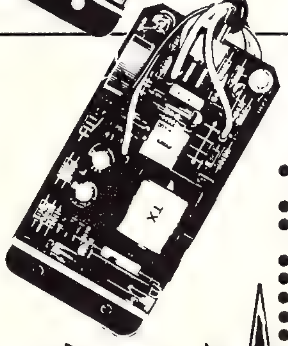

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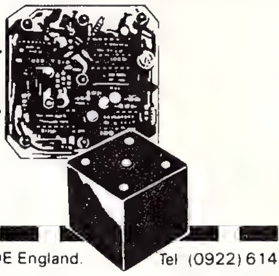

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DIGITAL Multimeter PDM 35, £18. Oscilloscope Telequip. D43 Dual Trace; leads; books; spares, £95 + post £4. P.E. Coughlin, 19, Victoria Crescent, Chelmsford, Essex CM1 1QF.

William Stuart's Big Ears Speech Recognition system for UK 101, spr. bd., Nascom, Atom. complete with Software, accessories, new, £43. K.Y. Chang, 70, 1-up, Ashley Street, Glasgow G3 6HW.

SYNTHESISER, Minisonic Mk2 + extras, ready to play — £180. 250 W Att. Stereo P.A. — £90. Elektor Teletext, working, £90. Offers? C.R. Leonard, 45, St. Anne's Close, Winchester SO22 4LQ. Tel. (0962) 65979.

PRINTER, Centronics 7392, all cables and RS 232 converter included. Must sell now, £125 o.n.o. Tel. Borden (Hants) 5818.

WANTED: Professional calibre audio mixer, TEAC type 2, Alice, Allen, & Weath, etc. Offers please to B.P. Hayward, 35 Dorchester Road, Solihull, W. Midlands. Tel. 021 705 3583.

TRANSCENDANT Synthesisers built, kits, perfect, offers. Two DFMS £15, Ohio Superboard 8K, £65, case + PSU, £25. £85 the pair. Hugh Bridge, 363 Kennington Lane, Vauxhall, London SE11 5QY. Tel. 01 735 1862.

PSUs: 5V 15A, ± 12V 1.5A, 12/24V 2A, £30; 5V 10A, ± 12V 1A, −12V 3A, £20; 5V 6A ± 12V 1.5A, 115V 1/P, £10; Twin Cassette I/F, £15. Tel. Milton Keynes (0908) 319765 after 6 p.m.

ELEKTOR 16K Dynamic RAM inc. ICs wired for Z80, £18.50 o.n.o. Tel. Hemel Hempstead 59472 after midday.

ACORN ATOM Basic Computer, brand new, unused, PSU Manual + Software, etc. Offers? Phono Caterham 42315.

WANTED: SE3A Scope Tube and Telequipment S32 Circuit Diagram. J. Glover, 1 Bryony Cottages, Hambledon, Godalming, Surrey GU8 4HJ. Tel. Wormley 4649.

SIRIUS 1 Personal Computer, 16 Bit, £1500 collect. Epson 100-3 Printer £350 o.n.o. collect. Tel. Preston 0772 37815.

WANTED: 8080/8085 Emulator Processor for Tektronix 8002A. W. Millar, 101 Ashgreen, Antrim BT41 1HN. Tel. 08494 66649.

FOR SALE: Larsholt 7254 FM Tunerset. RF Input to stereo AF Output. As new £20. A.D. Welsh, 50 Clumber Ave., Newcastle, Staffs ST5 3AX.

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47	100	9p
47	350	30p
1	63	8p
1	100	9p
1	500	40p
2.2	25	8p
2.2	63	9p
2.2	100	11p
2.2	350	30p
3.3	25	10p
3.3	40	11p
3.3	63	12p
4.7	16	8p
4.7	25	9p
4.7	40	11p
4.7	63	12p
4.7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
10	350	55p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
330	16	19p
330	25	22p
330	63	38p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2200	16	40p
2200	25	63p
2200	40	70p
2200	63	134p
4700	16	75p
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uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p

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100p 4KV	28p
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470p/2KV	27p
470p/6KV	32p
1n/2KV	28p
1n/6KV	32p
2n2/2KV	30p
2n2/4KV	32p
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2N1485	3.47
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2N2218	33p
2N2218A	25p
2N2219	27p
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2N2220	22p
2N2221	22p
2N2221A	23p
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2N2223A	4.15
2N2303	39p
2N2368	25p
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2N2405	88p
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2N2714	12p
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2N2875	2.20
2N2890	1.10
2N2891	2.28
2N2892	3.00
2N2904A	27p
2N2905	28p
2N2905A	29p
2N2906	25p
2N2906A	30p
2N2907	25p
2N2907A	26p
2N2920	3.47
2N2923	25p
2N2924	15p
2N2925	15p
2N2926	10p
2N3010	75p
2N3011	25p
2N3019	50p
2N3053	27p
2N3054	56p

2N3055H	60p
2N3055	120p
2N3107	46p
2N4240	42p
2N3109	48p
2N3232	1.50
2N3250	36p
2N3251	36p
2N3300	60p
2N3301	68p
2N3302	80p
2N3390	38p
2N3391	30p
2N3391A	34p
2N3392	27p
2N3393	24p
2N3394	20p
2N3395	26p
2N3396	26p
2N3397	27p
2N3402	35p
2N3403	50p
2N3404	50p
2N3405	50p
2N3416	24p
2N3417	23p
2N3420	2.50
2N3439	98p
2N3440	80p
2N3441	1.25
2N3442	1.35
2N3442RCA	1.85
2N3444	1.70
2N3445	4.80
2N3446	6.09
2N3447	5.72
2N3448	6.56
2N3468	1.00
2N3512	1.06
2N3553	2.30
2N3563	20p
2N3564	25p
2N3565	20p
2N3566	50p
2N3567	55p
2N3568	50p
2N3569	50p
2N3570	2.54
2N3571	2.19
2N3572	2.06
2N3584	2.76
2N3585	2.99
2N3605	36p
2N3606	28p
2N3607	28p
2N3632	9.88
2N3638	35p
2N3638A	37p
2N3639	36p
2N3641	39p
2N3642	25p
2N3643	15p
2N3644	28p
2N3645	33p
2N3646	28p
2N3662	15p
2N3663	16p
2N3691	18p
2N3692	20p
2N3693	25p
2N3694	30p
2N3702	10p
2N3703	10p
2N3704	10p
2N3705	10p
2N3706	10p
2N3707	10p
2N3708	10p
2N3709	10p
2N3710	10p
2N3711	10p
2N3712	2.00
2N3713	1.38
2N3714	2.98
2N3715	3.31
2N3716	3.60
2N3724	75p
2N3725	85p
2N3730	4.65
2N3732	2.88
2N3734	1.30
2N3725	2.45
2N3738	2.00
2N3740	2.38
2N3741	2.76
2N3766	2.90
2N3767	3.19
2N3771	1.75
2N3772	1.83
2N3773	2.06
2N3779	1.70
2N3789	3.27
2N3790	2.73
2N3791	2.47
2N3792	2.68
2N3749	25p
2N3819	21p
2N3820	38p
2N3821	1.84
2N3822	90p
2N3823	45p
2N3824	1.70
2N3826	78p
2N3827	78p
2N3854	44p
2N3855	30p
2N3855A	40p
2N3856	45p
2N3858	31p
2N3858A	37p
2N3859A	31p
2N3860	31p
2N3866	90p
2N3877A	35p
2N3900	25p
2N3901	30p
2N3902	6.65
2N3903	15p
2N3904	15p
2N3905	15p
2N3906	15p
2N3945	85p
2N3962	30p
2N3964	1.42
2N4030	66p
2N4031	55p
2N4032	65p
2N4036	58p
2N4037	43p
2N4058	10p
2N4059	17p
2N4060	12p
2N4061	10p
2N4062	10p
2N4064	1.15
2N4069	1.00
2N4074	75p
2N4092	98p
2N4093	1.20
2N4121	45p
2N4122	45p
2N4123	21p
2N4124	35p
2N4125	37p
2N4126	27p
2N4220	75p
2N4221	95p
2N4222	97p
2N4223	97p
2N4224	98p
2N4234	45p
2N4236	45p

2N4237	1.21
2N4238	95p
2N4239	1.00
2N4240	3.00
2N4248	15p
2N4249	17p
2N4250	17p
2N4258	75p
2N4266	45p
2N4275	48p
2N4284	32p
2N4285	35p
2N4287	45p
2N4288	22p
2N4289	15p
2N4290	45p
2N4291	45p
2N4292	45p
2N4294	45p
2N4297	2.50
2N4302	39p
2N4303	40p
2N4304	41p
2N4314	60p
2N4342	68p
2N4347	2.26
2N4351	1.16
2N4400	15p
2N4401	27p
2N4402	30p
2N4403	30p
2N4409	36p
2N4410	42p
2N4427	79p
2N4440	12.68
2N4870	80p
2N4871	55p
2N4888	92p
2N4898	1.29
2N4901	1.69
2N4902	3.52
2N4903	3.24
2N4904	2.75
2N4905	3.25
2N4906	3.42
2N4907	3.20
2N4908	3.70
2N4909	2.90
2N4910	1.95
2N4913	2.59
2N4914	2.69
2N4915	2.95
2N4916	48p
2N4917	47p
2N4918	95p
2N4919	1.28
2N4920	1.34
2N4921	55p
2N4922	69p
2N4923	99p
2N4924	92p
2N4926	95p
2N4927	95p
2N4928	1.59
2N4964	27p
2N4965	25p
2N4966	25p
2N4967	25p
2N4968	25p
2N4969	31p
2N5010	8.50
2N5011	9.37
2N5030	44p
2N5033	48p
2N5036	1.60
2N5036	1.95
2N5039	3.90
2N5086	36p
2N5087	39p
2N5088	37p
2N5089	37p
2N5126	48p
2N5217	38p
2N5128	38p
2N5129	30p
2N5130	37p
2N5131	22p
2N5133	22p
2N5135	38p
2N5136	38p
2N5137	23p
2N5138	18p
2N5139	48p
2N5140	25p
2N5141	25p
2N5143	25p
2N5172	15p
2N5175	58p
2N5179	39p
2N5180	43p
2N5183	1.00
2N5184	1.10
2N5188	1.15
2N5189	1.00
2N5190	68p
2N5191	70p
2N5193	90p
2N5194	79p
2N5209	24p
2N5210	25p
2N5219	25p
2N5220	15p
2N5221	25p
2N5222	28p
2N5223	15p
2N5224	38p
2N5225	25p
2N5226	25p
2N5227	25p
2N5232	30p
2N5232A	32p
2N5245	37p
2N5246	40p
2N5247	45p
2N5248	46p
2N5249	48p
2N5266	2.88
2N5293	98p
2N5294	1.28
2N5295	1.37
2N5296	1.28
2N5298	1.37
2N5302	3.20
2N5303	3.80
2N5305	25p
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2N5415	1.10
2N5416	1.54
2N5447	16p
2N5448	19p
2N5449	21p
2N5450	23p
2N5451	25p
2N5457	29p
2N5458	29p
2N5459	29p
2N5460	72p
2N5461	60p
2N5462	80p
2N5484	40p
2N5485	29p
2N5490	1.37
2N5492	1.56
2N5494	1.37
2N5496	1.59

2N5543	5.00
2N5551	37p
2N5640	45p
2N5654	35p
2N5786	80p
2N5813	23p
2N5884	7.28
2N6027	30p
2N6030	6.60
2N6082	11.99
2N6099	1.20
2N6101	1.30
2N6109	1.15
2N6111	1.00
2N6121	54p
2N6122	56p
2N6123	59p
2N6124	56p
2N6125	59p
2N6126	71p
2N6129	79p
2N6130	93p
2N6131	98p
2N6132	83p
2N6133	1.14
2N6134	1.36
2N6253	1.45
2N6254	1.55
2SC1306	95p
2SC2078	1.70
2SJ49	3.98
2SJ50	4.45
2SJ82	4.29
2SK134	3.98
2SK135	4.45
2SK226	4.29
3N139	3.30
3N140	2.37
3N143	2.85
3N152	3.00
3N153	2.47
3N154	2.56
3N200	6.93
3N201	2.98
40280	2.00
40290	2.00
40309	1.80
40311	97p
40312	1.64
40313	1.89
40315	1.94
40316	95p
40324	1.86
40325	2.46
40326	1.98
40346	1.30
40347	89p
40348	1.95
40360	60p
40361	67p
40362	67p
40363	2.22
40364	2.90
40372	1.80
40373	2.60
40374	2.84
40389	1.24
40390	2.72
40392	1.20
40394	1.10
40394	1.70
40406	1.39
40407	75p
40408	1.59
40410	1.80
40411	2.85
40412	90p
40422	2.95
40467A	1.29
40513	1.75
40537	96p
49543	1.60
40594	99p
40595	99p
40600	2.58
40601	2.36
40602	1.68
40603	1.09
40604	1.85
40608	2.44
40622	1.45
40625	1.60
40626	3.20
40631	1.90
40631	2.12
40635	1.35
40637	2.00
40643	1.80
40673	83p
40822	1.80
40871	89p
40872	89p
AC125	35p
AC126	25p
AC127	25p
AC128	25p
AC132	39p
AC151	51p
AC152	45p
AC153	55p
AC153K	64p
AC176	27p
AC176K	37p
AC187	25p
AC187K	28p
AC188	25p
AC188K	40p
ACY17	70p
ACY18	90p
ACY20	75p
ACY21	75p
ACY22	75p
ACY28	75p
ACY44	98p
AD136	6.75
AD145	1.65
AD149	79p
AD150	1.31
AD161	39p
AD162	39p
AF106	75p
AF109	75p
AF114	65p
AF117	70p
AF118	89p
AF124	72p
AF125	72p
AF126	72p
AF139	53p
AF170	88p
AF172	88p
AF178	88p
AF200	65p
AF201	75p
AF239	1.24
AF240	1.00
AF279B	75p
AF279G	75p
AL102	3.49
AU110	2.20
AU113	2.30
BC107	10p
BC107A	12p
BC107B	12p
BC108	10p
BC108A	12p
BC108B	12p
BC108C	14p
BC109	10p
BC109B	12p
BC109C	12p

BC113	30p
BC114	19p
BC115	22p
BC116	32p
BC116A	37p
BC117	19p
BC118	19p
BC119	38p
BC121	82p
BC123	82p
BC125	37p
BC132	39p
BC134	36p
BC135	45p
BC136	45p
BC137	39p
BC138	55p
BC140	29p
BC141	37p
BC142	29p
BC143	34p
BC147	10p
BC147A	10p
BC147B	10p
BC147C	20p
BC148	10p
BC148A	12p
BC148B	13p
BC148C	13p
BC149	10p
BC149B	12p
BC149C	13p
BC152	35p
BC153	23p
BC154	27p
BC157	11p
BC157A	12p
BC157B	13p
BC158	10p
BC158A	12p
BC158B	13p
BC159	11p
BC159A	12p
BC159B	13p
BC159C	18p
BC160	42p
BC161	48p
BC167	10p
BC167A	10p
BC167B	13p
BC168	10p
BC168B	10p
BC168C	10p
BC169	10p
BC169B	10p
BC169C	10p
BC170	15p
BC170A	17p
BC170B	17p
BC170C	18p
BC171	12p
BC171A	15p
BC171B	15p
BC172	12p
BC172A	15p
BC172B	15p
BC172C	16p
BC173	11p
BC173B	16p
BC173C	16p
BC174	21p
BC174A	24p
BC174B	24p
BC175	75p
BC177	16p
BC177A	25p
BC177B	26p
BC178	16p
BC178A	24p
BC178B	25p
BC179	20p
BC179A	25p
BC179B	25p
BC179C	27p
BC182	10p
BC182A	12p
BC182B	13p
BC182L	10p
BC182LA	13p
BC182LB	14p
BC183	10p
BC183A	11p
BC183B	12p
BC183C	13p
BC183L	10p
BC183LA	13p
BC183LB	13p
BC183LC	14p
BC184	10p
BC184B	12p
BC184C	13p
BC184L	10p
BC184LB	13p
BC184LC	14p
BC196	24p
BC187	24p
BC204	29p
BC205	29p
BC206	29p
BC207	29p
BC208	29p
BC209	29p
BC212	10p
BC212A	12p
BC212B	13p
BC212L	10p
BC212LA	13p
BC212LB	14p
BC213	10p
BC213A	11p
BC213B	12p
BC213C	13p
BC213L	10p
BC213LB	13p
BC213LC	14p
BC214	10p
BC214B	12p
BC214C	13p
BC214L	10p
BC214LB	13p
BC214LC	14p
BC237	14p
BC237A	16p
BC237B	17p
BC237C	18p
BC238	14p
BC238A	15p
BC238B	16p
BC238C	17p
BC239	15p
BC239A	16p
BC239B	17p
BC239C	18p
BC250	22p
BC250A	23p
BC250B	24p
BC250C	25p
BC251	25p
BC251A	26p
BC251B	27p
BC251C	28p
BC252	22p
BC252B	23p
BC252C	24p
BC253	22p
BC253B	23p
BC253C	24p
BC256	25p
BC256A	26p
BC256B	27p
BC257	26p
BC257A	27p
BC258	24p

BC258A	25p
BC258B	26p
BC259	25p
BC259B	26p
BC259C	27p
BC260	30p
BC260B	32p
BC260C	33p
BC261	33p
BC261A	34p
BC261B	35p
BC261C	36p
BC262	31p
BC262A	32p
BC262B	33p
BC262C	34p
BC263	30p
BC263B	31p
BC263C	32p
BC264	40p
BC264B	42p
BC266	35p
BC266A	36p
BC266B	37p
BC300	45p
BC301	44p
BC302	43p
BC303	47p
BC304	46p
BC307	13p
BC307A	14p
BC307B	15p
BC308	12p
BC308A	13p
BC308B	14p
BC309	14p
BC309A	15p
BC309B	16p
BC309C	17p
BC317	15p
BC318	15p
BC320	25p
BC321	25p
BC327	14p
BC328	14p
BC337	15p
BC338	15p
BC347	20p
BC350	20p
BC382	30p
BC382L	30p
BC383	30p
BC383L	30p
BC384	30p
BC384L	30p
BC407	30p
BC408	24p
BC409	30p
BC413	25p
BC414	25p
BC415	30p
BC416	30p
BC418	30p
BC440	32p
BC441	33p
BC460	32p
BC461	33p
BC478	29p
BC479	30p
BC516	40p
BC517	40p
BC547	13p
BC547A	14p
BC547B	14p
BC548	12p
BC548A	13p
BC548B	14p
BC548C	15p
BC549	13p
BC549B	14p
BC549C	15p
BC550	30p
BC550C	33p
BC557	15p
BC557A	16p
BC557B	16p
BC558	14p
BC558A	15p
BC558B	16p
BC559	15p
BC559B	16p
BC559C	17p
BC560	32p
BC560	32p
BC560C	34p
BC650	45p
BC651	46p
BCW32R	60p
BCY30A	1.30
BCY31	1.15
BCY31A	1.30
BCY32	1.15
BCY32A	1.30
BCY33	80p
BCY33A	1.00
BCY34	80p
BCY34A	80p
BCY54	1.91
BCY58	32p
BCY59	33p
BCY66	1.80
BCY67	2.00
BCY70	16p
BCY71	16p
BCY72	19p
BCY77	34p
BCY78	22p
BCY79	22p
BCY87	6.60
BCY88	4.90
BCY89	4.10
BCZ10	4.60
BCZ11	4.60
BD115	58p
BD116	2.50
BD121	2.25
BD124	1.50
BD131	44p
BD132	44p
BD135	40p
BD136	40p
BD137	42p
BD138	39p
BD139	39p
BD140	39p
BD142	2.40
BD153	1.25
BD155	1.20
BD157	54p
BD158	55p
BD160	3.80
BD181	1.75
BD182	2.50
BD183	2.70
BD187	1.09
BD201	1.30
BD202	1.39
BD204	1.44
BD220	1.00
BD221	95p
BD223	1.00
BD224	95p
BD232	1.11
BD233	70p
BD234	72p
BD237	98p
BD238	98p
BD239A	57p
BD239C	64p
BD240A	59p
BD240C	73p
BD241A	61p
BD241C	67p

BD242A	65p
BD242C	70p
BD243A	72p
BD143C	85p
BD244A	82p
BC244C	1.00
BD245A	1.14
BD245C	1.30
BD246A	1.20
BD246C	1.50
BC249A	2.00
BD249C	2.31
BD250A	2.11
BD250C	2.46
BD433	79p
BD434	55p
BD435	81p
BD436	81p
BD437	88p
BD438	88p
BD439	90p
BD440	91p
BD441	91p
BD442	93p
BD529	1.20
BD530	1.30
BD535	75p
BD536	75p
BD537	80p
BD538	80p
BD539	80p
BD539C	1.10
BD540	85p
BD540C	1.20
BD675	72p
BD676	77p
BD677	78p
BD678	83p
BD711	1.32
BD712	1.32
BDX14	1.30
BDX18	1.59
BDX32	3.47
BDY10	2.00
BDY11	2.50
BDY17	2.89
BDY23	3.40
BDY25	3.75
BDY38	1.74
BDY54	1.70
BDY55	1.75
BDY56	1.80
BDY57	5.25
BDY58	6.15
BDY60	1.60
BDY61	2.80
BDY62	2.34
BDY92	3.75
BF115	35p
BF119	1.00
BF121	75p
BF123	70p
BF127	80p
BF153	39p
BF154	25p
BF157	58p
BF158	25p
BF159	58p
BF160	55p
BF161	58p
BF163	50p
BF166	57p
BF167	29p
BF170	79p
BF173	25p
BF174	77p
BF177	25p
BF178	30p
BF179	35p
BF180	35p
BF181	36p
BF182	36p
BF183	38p
BF184	36p
BF185	37p
BF194	12p
BF195	12p
BF196	12p
BF197	12p
BF198	15p
BF199	15p
BF200	1.49
BF224J	32p
BF225J	35p
BF240	38p
BF241	38p
BF244A	35p
BF244B	39p
BF245A	
BF245B	51p
BF246	52p
BF246A	
BF246B	51p
BF247A	54p
BF247B	55p
BF254	39p
BF255	42p
BF256A	35p
BF256B	45p
BF256C	62p
BF257	30p
BF258	32p
BF259	35p
BF262	80p
BF263	90p
BF270	65p
BF271	68p
BF273	40p
BF274	40p
BF324	38p
BF336	36p
BF337	28p
BF338	48p
BF355	60p
BF362	85p
BF363	85p
BF457	46p
BF458	56p
BF459	62p
BF469	86p
BF470	86p
BFR39	25p
BFR40	25p
BFR41	25p
BFR79	25p
BFR80	25p
BFR81	25p
BFR90	2.11
BFS28	2.95
BFS61	1.00
BFS98	1.10
BFT19	1.65
BFT19B	1.88
BFT66	2.48
BFW10	1.48
BFW10	1.48
BFW11	1.48
BFW43	2.47
BFW59	1.06
BFW87	1.53
BFW90	1.53
BFX12	1.00
BFX13	91p
BFX19	50p
BFX20	80p
BFX29	26p
BFX30	27p
BFX34	1.00
BFX37	70p
BFX43	70p
BFX68	1.00
BFX84	27p
BFX85	28p

BFX86	28p
BFX87	25p
BFX88	26p
BFX89	1.75
BFY18	48p
BFY19	1.10
BFY37	1.20
BFY39	50p
BFY41	1.16
BFY50	23p
BFY51	23p
BFY52	23p
BFY53	31p
BFY56	31p
BFY56A	68p
BFY75	75p
BFY76	50p
BFY77	80p
BFY78	80p
BFY90	79p
BSV81	1.87
BSW41	95p
BSW67	1.00
BSW70	1.00
BSX19	24p
BSX20	24p
BSX21	40p
BSX27	78p
BSX28	66p
BSX29	34p
BSX39	80p
BSX60	75p
BSX61	80p
BSX76	50p
BSX77	55p
BSY24	77p
BSY25	1.00
BSY26	35p
BSY29	70p
BSY39	47p
BSY54	40p
BSY65	58p
BSY95A	25p
BU104	2.22
BU105	1.70
BU109	3.29
BU126	1.47
BU204	2.25
BU205	1.75
BU206	1.89
BU208	1.98
BU326S	2.35
BU406	1.45
BU407	1.45
BU408	1.35
BU409	1.25
BU500	2.95
BUV20	11.00
BUV21	10.90
BUV23	13.60
BUV24	12.10
BUV25	15.00
BUX20	17.00
BUY185	3.95
E430	4.99
J300	48p
J310	53p
MA8001	45p
MA8002	62p
MA8003	39p
MD7000	2.60
ME0401	25p
ME0402	30p
ME0404	25p
ME0411	35p
ME0412	35p
ME0413	35p
ME0414	48p
ME0461	45p
ME0462	45p
ME1001	45p
ME1002	45p
ME1075	45p
ME1100	45p
ME1120	48p
ME3002	25p
ME4001	45p
ME4002	45p
ME4003	45p
ME4101	25p
ME4101	25p
ME4103	25p
ME4104	25p
ME6001	25p
ME6002	25p
ME6003	25p
ME6101	29p
ME6102	28p
ME8001	47p
ME8002	62p
ME8003	50p
ME9001	56p
ME9002	56p
MFE3004	2.36
MJ400	2.98
MJ420	2.26
MJ430	2.98
MJ440	
MJ481	1.69
MJ491	1.72
MJ802	3.99
MJ900	2.90
MJ901	3.10
MJ1000	2.50
MJ1001	3.00
MJ1800	3.60
MJ2500	2.19
MJ2501	2.25
MJ2955	1.00
MJ3000	2.19
MJ3001	2.25
MJ3701	2.55
MJ4502	3.99
MJE340	53p
MJE370	97p
MJE371	99p
MJE520	92p
MJE521	94p
MJE1090	3.65
MJE1100	3.65
MJE2901	3.65
MJE2955	99p
MJE3055	69p
MP8111	1.00
MP8112	1.39
MP8121	1.35
MP8122	1.40
MP8123	1.16
MP8512	1.59
MPF102	39p
MPF103	29p
MPF104	29p
MPF105	29p
MPF112	59p
MPF121	1.69
MPS3638	27p
MPS3640	40p
MPS4356	60p
MPS6517	47p
MPS6518	47p
MPS6530	37p
MPS6560	32p
MPS6562	32p
MPSA05	23p
MPSA06	25p
MPSA10	28p
MPSA12	29p
MPSA13	48p
MPSA14	46p
MPSA16	30p
MPSA18	65p
MPSA20	48p

MPSA42	49p
MPSA43	49p
MPSA55	28p
MPSA56	30p
MPSA65	40p
MPSA66	47p
MPSA70	45p
MPSA92	39p
MPSA93	39p
MPSL01	42p
MPSL51	48p
MPSU01	84p
MPSU04	1.32
MPSU05	55p
MPSU06	56p
MPSU07	75p
MPSU51	88p
MPSU55	58p
MPSU56	59p
MPSU57	1.20
MRF421	poa
MRF453	poa
MRF454	poa
MRF475	7.55
MRF477	poa
MRF479	poa
MRF604	poa
NKT124	63p
NKT125	49p
NKT126	47p
NKT128	42p
NKT129	40p
NKT135	40p
NKT137	42p
NKT210	42p
NKT215	40p
NKT216	65p
NKT218	44p
NKT219	40p
NKT224	40p
NKT225	40p
NKT229	40p
NKT238	46p
NKT239	44p
NKT240	42p
NKT241	40p
NKT242	40p
NKT243	86p
NKT243	86p
NKT244	40p
NKT254	40p
NKT261	40p
NKT262	40p
NKT271	40p
NKT272	40p
NKT275	40p
NKT281	47p
NKT404	2.68
NKT405	2.80
NKT406	2.50
NKT453	2.40
NKT603F	56p
NKT613F	55p
NKT674F	55p
NKT677F	55p
NKT713	47p
NKT717	52p
NKT734	55p
NKT736	58p
NKT773	40p
NKT781	43p
NKT12329	50p
NKT12429	57p
NKT13329	50p
NKT13429	54p
NKT16229	59p
NKT20329	38p
OC20	2.30
OC22	2.00
OC23	2.00
OC25	2.50
OC28	1.70
OC29	2.35
OC35	2.35
OC41	80p
OC43	70p
OC44	82p
OC70	50p
OC71	50p
OC72	50p
OC82	50p
OC82D	70p
OC83	75p
P346A	58p
R2008B	2.14
R2010B	1.88
SC107	27p
SC108	27p
SC109	27p
TIP29A	32p
TIP29C	38p
TIP30A	35p
TIP30C	38p
TIP31A	38p
TIP31C	39p
TIP32A	38p
TIP32C	42p
TIP33A	65p
TIP33C	78p
TIP34A	74p
TIP34C	88p
TIP35A	1.09
TIP35C	1.28
TIP36A	1.29
TIP36C	1.39
TIP41A	49p
TIP41C	55p
TIP42A	55p
TIP42C	65p
TIP49	1.20
TIP50	1.40
TIP53	1.57
TIP54	1.59
TIP110	74p
TIP112	90p
TIP115	81p
TIP117	96p
TIP120	69p
TIP122	73p
TIP125	1.20
TIP127	1.27
TIP130	1.50
TIP132	1.60
TIP135	1.60
TIP137	1.80
TIP140	1.04
TIP142	1.04
TIP145	1.19
TIP147	1.19
TIP162	4.95
TIP2955	77p
TIP3055	70p
TIS37	62p
TIS43	40p
TIS45	66p
TIS46	66p
TIS47	49p
TIS48	65p
TIS49	66p
TIS50	60p
TIS51	65p
TIS52	70p
TIS53	97p
TIS54	85p
TIS55	66p
TIS58	92p

CRICKLEWOOD-STOCKING PARTS OTHER STORES CANNOT REACH!

Items not fully covered on this list include: **OPTO**· 7 seg LEDs, LCDs, bezelled LEDs, Lamps, Lampholders. **FUSES:** 20 mm, 1¼ inch, slow or quick blow, Fuseholders. **CONNECTORS:** DIL, DIN, Phono, 1 mm, 2 mm, 4 mm, Bulgin, USA, I.E C **KNOBS:** Plastic, Aluminium, Anodised, Collet, Pointer. **SWITCHES:** Toggle, Biased, Rocker, Rotary, Slide, DIL, Push **METERS:** LCD, Analogue, Test and Panel **TOOLS:** Pliers, Cutters, Strippers, Trimmers, Cable Cutters. And much, much more
All in stock items (that's 95%) posted same day. OFFICIAL ORDERS FROM SCHOOLS, GOVT. DEPTS ETC. WELCOME. OVERSEAS ORDERS WELCOME (CWO + ADEQUATE POSTAGE) QUANTITY DISCOUNTS BY NEGOTIATION.
CRICKLEWOOD ELECTRONICS LTD, 40 Cricklewood Broadway, London NW2 3ET, Tel· 01 452 0161, Telex: 914977

ALL STOCK BRAND NEW FRANCHISED ORIGIN

★ **THE LAZY WAY** Phone your order through on Access, Barclaycard, Visa or American Express for immediate service; no extra charge, no minimum order.
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TIS60	42p
TIS62	44p
TIS64	67p
TIS87	60p
TIS88A	62p
TIS90	28p
TIS91	30p
TIS92	30p
TIS93	54p
VN10KM	60p
VN46AF	84p
VN66AF	85p
ZTX107	10p
ZTX108	10p
ZTX109	10p
ZTX300	13p
ZTX301	15p
ZTX302	15p
ZTX303	23p
ZTX304	15p
ZTX310	35p
ZTX311	32p
ZTX312	35p
ZTX313	36p
ZTX314	24p
ZTX320	35p
ZTX330	35p
ZTX341	28p
ZTX500	14p
ZTX501	14p
ZTX502	14p
ZTX503	17p
ZTX504	24p
ZTX510	34p
ZTX530	24p
ZTX531	25p
ZTX650	45p

DIACS

BR100	40p
ST2	25p

THYRISTORS

Sensitive Gate
Small Signal

2N5060	30p
2N5061	32p
2N5062	35p
2N5063	37p
2N5064	40p
BR101	75p
BRY39	60p
BRY55-100	60p
BRY55-300	67p
BRY56	50p
TIC44	35p
TIC47	50p

4, 8 & 12 Amps Texas TO220

Suffix, A = 100V
B 200V
C - 300V
D - 400V
M - 600V

	TIC106A	46p
	TIC106B	47p
	TIC106C	48p
4A	TIC106D	59p
	TIC106M	68p
	TIC116A	66p
	TIC116B	68p
8A	TIC116C	71p
	TIC116D	73p
	TIC116M	80p
	TIC126A	72p
12A	TIC126B	72p
	TIC126C	73p
	TIC126D	77p
	TIC126M	95p

SIEMENS THYRISTORS

1 2 amp plastic	
Bst B0106 (100V)	60p
Bst B0113 (200V)	70p
Bst B0146 (700V)	1.12
4.7 amp plastic	
Bst B0206 (100V)	80p
Bst B0213 (200V)	1.10
Bst B0246 (700V)	2 00

TV Thyristors

2N4444	1.80
BT101-500R	1 40
BT106	1.50
BT116 Use TIC116M	
BT119	1.70
BT120	1.50
BT121	1.30
BT139/600	2.50

TRIACS

Texas 400V
TO220 Case

TIC206D(4A)	66p
TIC225D(6A)	74p
TIC226D(8A)	88p
TIC236D(12A)	1.16
TIC246D(16A)	1.22
TIC253D(20A)	1.90
TIC263D(25A)	2.11

Other Triacs

2N5756 (TO5)	1.44
2N6155 (TO127)	3.39
40432 (Quadrac)	2.23
40486 (TO5)	1.65
40512	2.70
40576 (TO66)	3.33
40842	1 92

DIODES

1N34A	30p
1N821	70p
1N823	92p
1N914	4p
1N916	6p
1N1190	1.47
1N1192	1.75
1N1194	1.65
1N1194A	1.80
1N1196A	2.41
1N1198A	2.65
1N1201A	97p
1N1204A	1.00
1N1206	1.20
1N3063	36p
1N3065	48p
1N3492	1.85

1N3493	2.20
1N3493R	2.20
1N3602	36p
1N3604	45p
1N3766	3.00
1N3768	4.50
1N3768R	4.50
1N4001	4p
1N4002	4½p
1N4003	5p
1N4004	5½p
1N4005	6p
1N4006	6½p
1N4007	7p
1N4009	20p
1N4148	6p
1N4150	18p
1N4448	22p
1N4517	22p
1N5172	30p
1N5176	94p
1N5400	12p
1N5401	13p
1N5492	14p
1N5403	15p
1N5404	16p
1N5405	17p
1N5406	18p
1N5407	19p
1N5408	20p
1N5024	52p
1N5625	60p
1N5626	62p
1N5627	68p
1S44	10p
1S131	40p
1S134	56p
1S421	1.00
1S421R	1.00
1S940	10p
1S941	11p
1S961	22p
AA119	28p
AA129	57p
AA144	25p
AAY30	44p
AAY33	46p
AAZ17	27p
BA100	22p
BA102	25p
BA115	25p
BA133	40p
BA138	30p
BA142	20p
BA144	15p
BA155	15p
BA156	38p
BA182	40p
BA201	18p
BA202	26p
BA316	25p
BA317	25p
BA318	30p
BAV10	16p
BAV19	15p
BAV20	15p
BAV49	15p
BAX13	10p
BAX16	11p
BAY38	20p
BAY44	15p
BAY93	10p
BB103B	70p
BB103G	70p
BB104B	80p
BB104G	80p
BB105	52p
BB105A	57p
BB105B	58p
BB109G	65p
BY126	20p
BY127	22p
BY134	52p
BY182	1.26
BY188A	65p
BY206	36p
BY207	36p
BY223	1.56
BY297	48p
BY299	55p
BYW11-800	1.40
BYW11-1000	2.00
BYW12-100	1.30
BYW12-200	1.40
BYW12-400	2.00
BYX10	36p
BYX50-200R	2.00
BYX55-350	62p
BYX71-350	1.10
BYX71-600	1.52
ITT33	15p
ITT44	10p
ITT921	10p
ITT923	15p
ITT2002	27p
MZ2361	1.80
OA10	70p
OA47	20p
OA90	10p
OA91	10p
OA95	20p
OA200	20p
OA202	20p
RAS508AF	75p
SPD9000	75p
SPD9002	95p

BRIDGE RECTIFIERS

(PIV shown in brackets)

1 amp type	
W01 (100)	20p
W02 (200)	26p
W04 (400)	28p
W08 (800)	40p
6 amp type Square with hole	
2 amp type Square with hole	
S01 (100)	37p
S02 (200)	40p
S04 (400)	40p
S08 (800)	55p
PW01 (100)	50p
PW02 (200)	78p
PW04 (400)	86p
PW06 (600)	90p
25 amp type Metal clad with hole	
K01 (100)	2.20
K02 (200)	2.30
K04 (400)	2.80
K06 (600)	3.40
Proprietory Bridges	
B40C1500	1.20
B80C3700	1.80
BY164	55p
BY179	92p

ZENER DIODES

400-500 mW E24 Series 2 4-47 V	8p
1 3 Watt E24 Series 3 3-82 V	15p
2 5 Watt E24 Series 7 5-75V	1 10
5W wire ended following voltages only 3V3, 3V6, 4V3, 4V7, 5V6, 7V5, 8V2, 8V7, 9V1, 10V, 12V, 20V, 33V, 51V, 62V, 68V	1.25
10W Pos. Stud Following voltages only 7V5, 13, 18, 20, 24, 27, 30, 33, 68, 82, 91, 100, 110	1.25
20W Pos Stud (BZY93 series) E24 values 7V5-75V	2.00

OPTO ELECTRONICS

2N5777	78p
2N5778	88p
2N5779	1.09
4N25	1.10
BP100	1.40
BP104	1.00
BPX25	2 47
BPX29	2 47
BPX48	6 76
BPX60	4 75
BPX61	3 48
BPX63	2 93
BPX79	4.60
BPX86	4.15
CQX13	40p
CQX23	53p
CQX33	48p
LD30A	15p
LD36A	18p
LD37A	18p
LD52A	12p
LD56A	15p
LD57A	15p
LD52C	30p
LD56C	30p
LD57C	30p
LD80A	18p
LD86A	22p
LD87A	22p
LD242	75p
LD271	40p
LD461	25p
LD466	1.45
LD468	1.65
LD471	27p
LD476	1 20
LD478	1.45
LD479	1.65
LD481	27p
LD486	1.25
LD488	1 70
LD489	1 89
LD599	81p
ORP12	1.20
RPY60	2.65
RPY63	2 65
TIL32	71p
TIL63	1.95
TIL64	1.95
TIL65	2 25
TIL66	2 30
TIL67	2 35
TIL78	60p
TIL81	1.60
TIL99	1 35
TIL116	1 10
TIL138	2 40
TIL139	2 40
TIL209	15p
TIL211	19p
TIL212	19p
TIL224	32p
TIL228	42p
TIL312	1.65
TIL313	1.65
TIL401	3.50
TIL403	3.80
TIL406	4.10

NEW OPTO DEVICES

inc. Superbright - see below

SWITCHES

DIL SPST	
4 way	67p
6 way	82p
8 way	90p
10 way	1.40
Toggle (mini)	
SPST	49p
SPDT	59p
DPDT	69p
DPDT C. off	79p
4PDT	2.75

D. CONNECTORS 25 WAY

Solder type	
Male	1.60
Fmale	2.05
Angled PCB	
Male	2.45
Fmale	2.90
Covers	99p

NEW OPTO DEVICES

New LEDs
Now in stock
R = red
G = green
Y = yellow

Large diffused	1+	50+
R5D	9p	7p
G5D	15p	12p
Y5D	15p	12p

Small diffused		
R2D	8p	6p
G2D	12p	10p
Y2D	12p	10p
Micro 0 1"		
R1D	25p	22p
G1D	27p	25p
Y1D	27p	25p
Large clear		
R5C	12p	10p
G5C	17p	13p
Y5C	17p	13p
Super bright Large (100 times brighter)		
R5U	38p	29p
G5U	42p	34p
Y5U	42p	34p
Tri colour flat		
RGY8	83p	78p

LINEAR ICs

AY1-5050	95p
AY3-8910	5.39
AY3-8912	5.59
AY5-2376	5.89
CA3000	4 80
CA3001	4.95
CA3002	4.60
CA3005	3.15
CA3007	4.92
CA3010	1.30
CA3012	1.75
CA3013	4.12
CA3014	2.35
CA3015	2.62
CA3018	75p
CA3018A	2.00
CA3020	2.00
CA3020A	3.90
CA3021	3.20
CA3022	3.12
CA3026	1.52
CA2028A	1.21
CA3028B	2.53
CA3029	1.44
CA3030A	2.97
CA3033	5.44
CA3034	5.18
CA3036	2.75
CA3039	1.50
CA3041	3.47
CA3042	3.47
CA3043	3.92
CA3046	69p
CA3047	4.60
CA3048	2 99
CA3049	3.21
CA3050	4.11
CA3051	3.80
CA3052	2.92
CA3053	1.00
CA3054	1.66
CA3059	2.80
CA3060	4.09
CA3062	13.84
CA3065E	4.62
CA3068	4.23
CA3070	3.20
CA3071	3.30
CA3075	2.25
CA3076	3.42
CA3078T	2.25
CA3080	1.89
CA3080A	3.95
CA3080E	70p
CA3081	1.90
CA3085	1.35
CA3086	55p
CA3089E	1.95
CA3090AQ	3.70
CA3130E	87p
CA3130T	1.80
CA3140E	39p
CA3140T	85p
HA1366W	2.40
HA1388	2.54
ICL7106	7.40
ICL7107	9.50
ICL8038	2.99
ICM7555	80p
LC7120	3.20
LC7130	3.20
LC7137	4.00
LF347	1.50
LF351	47p
LF353	92p
LF355	83p
LF356	92p
LF357	1.09
LF13201	2.99
LF13331	3.30
LF13741H	68p
LF13741N	59p
LM10CH	4.25
LM11CH	4.50
LM114	6.75
LM137K	11.52
LM301AH	1.00
LM301AN	25p
LM305AH	2.90
LM305H	88p
LM307H	1.05
LM307N	55p
LM308AH	3.15
LM308AN	2.14
LM308H	95p
LM308N	88p
LM309K	2.80
LM310H	1.95
LM310N	1.89
LM311H	1.04
LM311N	70p
LM317K	2.80
LM317MP	1.04
LM318H	2.40
LM318N	1.49
LM319H	2.48
LM319N	2.10
LM320 – See 79XX Series Volt	
Regulators	
LM324N	29p
LM337K	4.75
LM337MP	1.65
LM337T	1.99
LM339AN	1.60
LM339N	47p
LM340 – See 78XX Series Volt	
Regulators	
LM345K	3.60
LM348N	62p
LM349N	1.16
LM350K	4.60
LM359N	1.44
LM360N	3.88
LM376N	65p
LM377N	1.69
LM378N	3.40
LM379S	4.79
LM380N14	75p
LM380N8	1.50

LM381AN	2.26
LM381N	1.40
LM382N	1.12
LM383T	3.40
LM384N	1.40
LM386N1	88p
LM386N4	1.20
LM388N	2.43
LM391N60	1.70
LM391N80	1.93
LM392N	76p
LM393N	96p
LM394H	3.80
LM396K	13.52
LM709N8	64p
LM709CH	1.00
LM710CH	89p
LM710CN	52p
LM711CH	1.38
LM711CN	70p
LM723CH	1.21
LM723CN	40p
LM725CH	3.40
LM725CN	3.19
LM733CN	69p
LM741CH	96p
LM741CN	15p
LM741CN14	80p
LM747CN	69p
LM748CH	1.00
LM748CN	35p
LM1303N	1.20
LM1304N	2.50
LM1305N	3.10
LM1307N	2.75
LM1310N	1.45
LM1330N	2.25
LM1458	44p
LM1496	1.08
LM1800	3.24
LM1801	2.99
LM1812	8.00
LM1818	2.99
LM1820	2.15
LM1828	4.79
LM1830	2.44
LM1845	4.12
LM1848	2.89
LM1850	2.75
LM1871	4.39
LM1872	4.39
LM1886	7.44
LM1889	3.77
LM2907N	2.75
LM2907NB	2.60
LM2917N	1.89
LM2917N8	1.89
LM3524	6.77
LM3301	1.60
LM3302	74p
LM3401	65p
LM3404	75p
LM3405	1.45
LM3900	48p
LM3905	1.25
LM3909	79p
LM3911	1.20
LM3914	1.79
LM3915	1.99
LM3916	2.19
LM4250CH	2.63
LM4250N	2.39
LM13600	1.09
MB3712	1.99
MB3756	3.80
MB8719	7.95
M53200	8.54
MC1303= LM1303N	
MC1304= LM1304N	
MC1305= LM1305N	
MC1307= LM1307N	
MC1310= LM13010N	
MC1330= LM1330N	
MC1352	1.75
MC1456	1.80
MC1458= LM1458	
MC1466L	6.77
MC1495L	3.75
MC1496- LM1496	
MC3340	1.45
MC3401- LM3401	
MC3403- LM3403	
MC3405= LM3405	
NE531N	1.36
NE540L	4.95
NE543N	2.50
NE544N	1.80
NE555	16p
NE556	45p
NE558	1.89
NE560	3.25
NE565	1.18
NE566	1.49
NE567	1.37
NE570	4.07
NE571	3.99
NE5534	95p
OM335	7.20
PLL02A	4.95
PLL03A	12.75
RC4136	59p
RC4194	3.95
RC4195	2.95
S556B	2.59
SAD1024A	8.49
SAS560	2.59
SAS570	2.59
SAS580	2.95
SAS590	2.95
SFF96364	7.99
SL470	3.47
SL490	3.47
SL610C	4.00
SL611C	4.00
SL612C	4.00
SL620C	6.00
SL621C	6.00
SL623C	10.00
SL630C	6.00
SL640C	6.00
SL641C	6.00
SN76001N	2.80
SN76008	3.90
SN76018	3.90
SN76003N	2.95
SN76013N	2.95
SN7023N= SN76033N	
SN76033N	2.95
SN76110	2.25
SN76115	2.65
SN76116	2.75
SN76226	3.45
SN76228	2.90
SN76477	4.49
SN76530	1.80
SN76550	80p
SN 76666	2.90
SO41P	2.25

SO42P	2.25
TA7210	1.49
TA7204	1.95
TA7205	89p
TA7222	1.45
TA7310	1.49
TAA263	3.88
TAA300	3.95
TAA320	2.05
TAA350	3.60
TAA521	1.50
TAA522	2.47
TAA550	73p
TAA560	2.35
TAA570	2.35
TAA621AX1	2.75
TAA661A	1.50
TAA661B	1.70
TAA700	2.60
TAA930	2.50
TAA930B	2.63
TAA970	2.45
TAA991D	2.45
TAD100	2.00
TBA120AS	69p
TBA331	1.50
TBA341	2.05
TBA395	1.65
TBA396	1.50
TBA450	1.95
TBA460	1.53
TBA500	2.97
TBA500Q	3.11
TBA510	2.95
TBA510Q	3.05
TBA520	2.57
TBA520Q	2.75
TBA530	2.55
TBA530Q	2.76
TBA540	2.72
TBA540Q	2.74
TBA550	3.25
TBA550Q	3.27
TBA560C	2.87
TBA570	2.37
TBA570Q	2.48
TBA581	3.11
TBA641	3.00
TBA651	1.90
TBA673	4.15
TBA700	2.38
TBA700Q	2.47
TBA720AQ	2.60
TBA750	2.25
TBA750Q	2.46
TBA790A	2.11
TBA800	78p
TBA810	95p
TBA820	75p
TBA820M	75p
TBA920	1.95
TBA920Q	1.97
TBA950	2.25
TBA990	2.65
TBA990Q	2.74
TCA105	3.00
TCA160C	2.67
TCA220	3.44
TCA270	2.44
TCA440	2.20
TCA450	2.65
TCA640	4.15
TCA650	4.15
TCA660B	4.15
TCA730	4.80
TCA740	4.80
TCA750	4.85
TCA760	2.75
TCA800	3.50
TBA800Q	3.60
TCA830S	1.90
TCA910	2.19
TCA940	1.69
TDA1002	3.39
TDA1003	3.94
TDA1004	3.94
TDA1005	3.94
TDA1010A	1.79
TDA1022	4.95
TDA1024	1.19
TDA1034	3.20
TDA2020	2.99
TDA2030	2.85
TDA2522	4.20
TDA2530	3.30
TDA2540	4.10
TDA2541	4.10
TDA2560	4.10
TDA2571	4.40
TDA2581	3.75
TDA2590	5.20
TDA2591	4.73
TDA2600	6.15
TDA2610	3.90
TDA2611A	2.50
TDA2640	3.64
TDA3000	2.76
TL061	40p
TL062	60p
TL064	99p
TL071	36p
TL072	50p
TL074	1.30
TL081	50p
TL082	75p
TL083	85p
TL084	89p
TL170	49p
TL430	69p
UAA170	1.69
UAA180	1.69
ULN2003	85p
UPC575C2	2.65
UPC1156	2.75
XR2206	2.92
ZN414	1.20
ZN419	2.25
ZN1034	1.99
ZN1040	6.69
ZTK22	89p
ZTK33	89p

TTL

7400	11p
7401	11p
7402	11p
7403	12p
7404	12p
7405	15p
7406	20p
7407	20p
7408	14p
7409	14p
7410	14p
7411	16p
7412	18p
7413	18p
7414	25p
7416	20p
7417	20p
7420	15p
7421	20p
7422	20p
7423	20p
7425	24p
7426	28p
7427	22p
7428	26p
7430	14p
7432	22p
7433	22p
7437	25p
7438	25p
7440	15p
7441	65p
7442	32p
7443	90p
7444	90p
7445	50p
7446	60p
7447	40p
7448	44p
7450	15p
7451	15p
7453	15p
7454	14p
7460	15p
7470	34p
7472	25p
7473	25p
7474	20p
7475	25p
7476	28p
7480	49p
7481	1.19
7482	68p
7483	38p
7484	69p
7485	60p
7486	20p
7489	2.20
7490	20p
7491	35p
7492	25p
7493	25p
7494	36p
7495	36p
7496	40p
7497	90p
74100	80p
74104	50p
74105	55p
74107	22p
74109	25p
74110	35p
74116	50p
74118	59p
74119	80p
74120	59p
74121	25p
74122	40p
74123	40p
74125	35p
74126	34p
74128	36p
74132	29p
74136	30p
74141	55p
74142	1.99
74143	2.48
74144	2.10
74145	50p
74147	89p
74148	70p
74150	49p
74151	40p
74153	40p
74154	49p
74155	40p
74156	40p
74157	30p
74159	75p
74160	60p
74161	48p
74162	48p
74163	48p
74164	48p
74165	48p
74166	48p
74170	1.25
74172	2.75
74173	60p
74174	59p
74175	49p
74176	39p
74177	45p
74178	79p
74180	40p
74181	1.15
74182	60p
74184	90p
74185	90p
74186	4.69
74188	2.50
74190	48p
74191	48p
74192	45p
74193	45p
74194	45p
74195	46p
74196	45p
74197	48p
74198	83p
74199	83p
74221	53p

74LS TTL

74LS00	11p
74LS01	11p
74LS02	11p
74LS03	12p
74LS04	12p
74LS05	12p
74LS08	12p
74LS10	12p
74LS11	12p
74LS12	12p
74LS13	19p
74LS14	30p
74LS15	12p
74LS20	12p
74LS21	12p
74LS22	12p
64LS27	12p
74LS28	14p
74LS30	12p
74LS32	13p
74LS33	14p
74LS37	14p
74LS38	15p
74LS40	13p
74LS42	28p
74LS47	35p
74LS51	14p
74LS54	14p
74LS55	14p
74LS73	18p
74LS74	18p
74LS75	20p
74LS76	20p
74LS78	18p
74LS80	1.20
74LS83	36p
74LS85	48p
74LS86	16p
74LS90	24p
74LS92	25p
74LS93	24p
74LS95	39p
74LS96	96p
74LS107	20p
74LS109	27p
74LS112	22p
74LS113	22p
74LS114	22p
74LS122	36p
74LS123	36p
74LS124	89p
74LS125	24p
74LS126	25p
74LS132	39p
74LS136	29p
74LS138	32p
74LS139	30p
74LS145	70p
74LS147	1.57
74LS148	75p
74LS151	39p
74LS153	39p
74LS154	79p
74LS155	29p
74LS156	36p
74LS157	27p
74LS158	29p
74LS160	35p
74LS161	35p
74LS162	35p
74LS163	35p
74LS164	40p
74LS165	59p
74LS168	84p
74LS169	85p
74LS170	70p
74LS173	55p
74LS174	45p
74LS175	39p
74LS181	99p
74LS183	1.79
74LS190	36p
74LS191	36p
74LS192	36p
74LS193	37p
74LS194	32p
74LS195	32p
74LS196	45p
74LS197	48p
74LS221	50p
74LS240	55p
74LS241	55p
74LS242	55p
74LS243	55p
74LS244	60p
74LS245	70p
74LS247	50p
74LS248	55p
74LS249	55p
74LS251	30p
74LS253	32p
74LS257	35p
74LS258	35p
74LS259	55p
74LS261	1.35
74LS266	18p
74LS273	60p
74LS275	2.25
74LS279	30p
74LS280	1.60
74LS283	40p
74LS289	4.70
74LS290	45p
74LS293	40p
74LS295	89p
74LS298	89p
74LS299	2.50
74LS323	1.76
74LS324	1.45
74LS325	2.96
74LS326	2.39
74LS327	2.39
74LS347	95p
74LS348	1.00
74LS352	79p
74LS353	79p
74LS362	7.25
74LS365	29p
74LS366	29p
74LS367	29p
74LS368	29p
74LS373	59p
74LS378	58p
74LS386	1.14
74LS390	46p
74LS393	42p
74LS395	89p
74LS396	1.90
74LS398	2.70
74LS399	1.59
74LS445	99p
74LS490	2.20
74LS540	77p
74LS541	99p
74LS640	1.60
74LS641	1.69
74LS643	2.25
74LS644	2.75
74LS669	1.20
74LS670	1.40
74LS673	5.50
74LS674	9.99
74LS688	1.19

74S TTL

74S00	30p
74S02	32p
74S04	32p
74S08	75p
74S20	60p
74S30	60p
74S32	70p
74S40	1.45
74S64	1.02
74S65	1.02
74S74	75p
74S85	2.99
74S86	1.75
74S112	90p
74S113	90p
74S124	2.95
74S132	1.09
74S133	60p
74S138	1.25
74S139	1.49
74S140	2.50
74S153	7.95
74S157	2.75
74S163	3.00
74S174	2.50
74S175	3.20
74S188	3.50
74S189	3.50
74S194	3.50
74S200	4.50
74S201	4.00
74S225	5.25
74S261	3.00
74S262	8.50
74S287	2.99
74S288	1.99
74S289	1.57
74S301	3.20
74S470	3.25
74S471	6.25
74S473	12.50
74S474	3.99
74S475	8.25
74S571	9.00
74S573	9.00

74H TTL

74H00	1.45
74H01	1.45
74H04	1.55
74H05	1.55
74H10	1.45
74H11	1.45
74H20	1.45
74H21	1.45
74H30	1.45
74H40	1.55
74H51	1.75
74H53	1.65
74H54	1.45
74H55	1.40
74H60	1.70
74H62	1.75

74L TTL

74L02	1.00
74L10	1.70
74L47	3.27
74L74	1.20
74L85	4.20
74L86	1.50
74L93	2.30
74L98	2.99

74 CMOS/TTL

74C00	27p
74C04	29p
74C10	28p
74C14	89p
74C20	28p
74C30	36p
74C42	96p
74C48	1.40
74C73	54p
74C76	57p
74C83	1.74
74C85	1.34
74C86	1.10
74C89	5.95
74C90	1.05
74C93	1.44
74C95	1.00
74C107	60p
74C151	2.55
74C154	4.95
74C157	2.20
74C160	1.54
74C161	1.15
74C162	1.16
74C163	65p
74C164	1.15
74C165	2.00
74C173	98p
74C174	65p
74C175	75p
74C192	89p
74C193	68p
74C194	89p
74C195	70p
74C200	10.00
74C221	1.20
74C901	1.91
74C902	71p
74C903	2.30
74C904	1.84
74C905	10.88
74C907	1.91
74C908	1.87
74C911	9.59
74C912	8.00
74C914	2.88
74C915	1.99
74C918	2.50
74C920D	8.50
74C922	4.50
74C923	5.00
74C925	6.00
74C926	6.58
74C928	6.00
74C929	5.20
74C930J	7.80
74C932	3.12

40 CMOS

4000	10p
4001	10p
4002	11p
4006	49p
4007	15p
4008	32p
4009	24p
4010	10p
4011	10p
4012	15p
4013	20p
4014	46p
4015	58p
4016	20p
4017	32p
4018	45p
4019	26p
4020	44p
4021	39p
4022	48p
4023	12p
4024	32p
4025	12p
4026	79p
4027	20p
4028	29p
4029	29p
4030	14p
4031	1.19
4032	80p
4033	1.20
4035	1.29
4035	59p
4036	2.49
4037	1.30
4038	99p
4039	2.80
4040	46p
4041	40p
4042	39p
4043	46p
4044	41p
4045	99p
4046	44p
4047	39p
4048	39p
4049	22p
4050	23p
4051	44p
4052	49p
4053	49p
4054	79p
4055	83p
4056	89p
4059	4.35
4060	42p
4063	79p
4066	22p
4067	2.49
4068	14p
4069	13p
4070	13p
4071	13p
4072	13p
4073	13p
4075	13p
4076	45p
4077	13p
4078	13p
4081	12p
4082	12p
4085	49p
4086	53p
4089	1.50
4093	20p
4094	69p
4095	66p
4096	90p
4097	2.88
4098	74p
4099	90p

For higher numbers in 40 Series, substitute 74C for 40 prefix, eg 40107 = 74C107

45 CMOS

4502	59p
4503	29p
4507	33p
4508	1.19
4510	35p
4511	48p
4512	39p
4514	1.17
4515	1.17
4516	59p
4518	39p
4519	29p
4520	48p
4521	99p
4526	59p
4527	59p
4528	46p
4532	69p
4534	4.29
4536	2.59
4538	65p
4539	99p
4543	56p
4553	2.25
4555	35p
4556	35p
4560	1.49
4566	1.49
4569	1.59
4584	39p
4585	79p

COMPUTER ICs

CPUs

1802	7.00
2650A	11.99
6502	3 24
6800	2.74
6802	2.69
6809	8.50
8035	3.49
8060	10.90
8080A	2.79
8085A	3.49
8900	57.75
9980	21 00
SCMP1	17.66
Z80A	3.50

MEMORIES

2101	4.00
2102AL2	1.35
2111-1	3.00
2114(200ns)	85p
2532	3.60
2564	11.95
2708	2.25
2716 (5v)	2.11
2764	9.75
4027	3.00
4044	7.00
4060	9.50
4116(200ns)	75p
4118-3	3.25
4164	4.50
5204	7.50
6116	4.40
6514	3.30
6810	1.15
7489	4.20
74189	4.00
74LS289	3.25
74LS188	2.25
74LS287	3.05
74LS288	2.25

ZERO INSERTION DIL SOCKETS

24pin	4.90
40pin	5.30

LOGIC ICs

inc COMP. SUPPORT

ADC0804	3.95
ADC0816	14.90
ADC0817	10.06
AY5-1013A	3.00
AY5-2376	5.90
ICM7555	80p
INS1671	20.00
INS1771	20.00
INS1792	30.00
MC1466L	6.50
MC1488	55p
MC1489	55p
MC4024	3.25
MC4044	3.25
MK50250	10.00
MK50398	6.95
MM5303	6.25
MM5307	12.75
MM5357	22.50
MM57105	14.00
MM57109	12.00
MM57160	9.00
MM57161	9.00
MM58174	11.80
RO2513LC	6.99
RO2513UC	7.50
SAA5000	3.00
SAA5010	7.10
SAA5012	7.10
SAA5020	5.50
SAA5030	9.00
SAA5040	15 00
SAA5041	15.00
SAA5050	8.50
SAA5052	8.50
TMS6011	3.65
ULN2003A	85p
8T26	1.35
8T28	1.35
8T95	1.35
8T97	1.35
81LS95	90p
81LS96	1.20
81LS97	90p
81LS98	1.20
6522	3.19
6532	6.95
6821	1.12
6845	10.00
6847	10.00
6850	1.35
6852	2.40
6875	4.85
8131	3.75
8154	9.42
8155	3.50
8212	1.10
8216	1.00
8223	1.80
8224	1.10
8226	2.50
8228	2.50
8238	5.75
8243	4.68
8250	8.65
8251	3.15
8253	7.95
8254	10.00
8255	2.48
8257	4.00
8259	4.00
8279	4.40
8304	4.50
8544	1.50
8601	1.20
8832	2.60
8833	2 35
9097	3.00
9099	3.00
9601	5.50
9062	2 50
Z80ACTC	2.65
Z80ADART	8.00
Z80ADMA	10.00
Z80AP10	2.80
ZN425E8	3.39
ZN426E8	3.39
ZN427E8	5.99
ZN428E8	4.05

VOLTAGE REGULATORS

(See also Linear ICs)

– Positive –	
100 mA	
78L05A	30p
78L12A	30p
78L15A	30p
78L24A	30p
100 mA TO5	
78L05CH	80p
78L12CH	80p
78L15CH	80p
78L24CH	80p
500 mA TO202	
7805M	47p
7812M	47p
7815M	47p
7842M	47p
1 Amp TO220	
7805T	39p
7812T	39p
7815T	39p
7824T	39p
1.5 Amp TO03	
7805K	1.39
7812K	1.39
7815K	1.39
7824K	1.39
– Negative –	
100 mA TO92	
79L05	59p
79L12	59p
79L15	59p
500 mA TO202	
7905M	55p
7912M	55p
7915M	55p
7924M	55p
1 Amp. TO220	
7905T	44p
7912T	44p
7915T	44p
7924T	44p
1.5 Amp TO3	
7905K	1.99
7912K	1.99
7915K	1.99
7924K	1.99
– Variable –	
L200 (2A Pos)	2.50
LM137K	12.00
LM309K	1.35
LM317K	3.42
LM317MP	95p
LM317T	1.75
LM337K	4.60
LM337MP	1.73
LM337T	1.75
LM345K	3.60
LM350K	4.50
LM396K	13.52

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1,000s SOLD GREAT VALUE!

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EF9365	£ 44.00
EF9366	£ 44.00

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TO1 (AC128)	18p
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TO18 (BC109)	18p
TO220 (TIP29)	36p

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HP2(4AH)	4.75
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Chargers
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100KHz	2.49
200KHz	2.79
1 00MHz	2.89
1 008MHz	2.74
2 00MHz	2.24
2 097152MHz	3 50
3 2768MHz	1.50
4 00MHz	1.40
4 194394MHz	2.00
4 433619MHz	1.10
5 00MHz	1.75
6 00MHz	1.50
6 9375MHz	3.50
8 00MHz	1.75
10 00MHz	1.75
18 00MHz	1.99
20 00MHz	1.99
27 648MHz	2.60
48 00MHz	1.75
100 00MHz	5.50
5.5 MHz Ceramic filter	90p

VALVES

DY86/87/802	1.32
ECC82	1.22
ECC83	1.22
ECC84	1.22
EF86	1.80
EL34	2.89
EL84	2 60
KT66	10.76
KT88	12.60
PC900	1.76
PCC84	3.00
PCC85	3.40
PCC89	1 89
PCF86	2.30
PCF201	3.00
PCF801	2.67
PCF802	2.11
PCL82	1.80
PCL85	2.20
PCL86	2.10
PCL805	2.20
PD510	4.95
PFL200	2 99
PL504	2.11
PL508	2.36
PL519	7.75
PL802	4.17
PY88	1.62
PY500A	2.63
6L6	2.59

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Low loss, superior quality 50Ω

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Sqr skt	49p
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Line skt	1.16

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Male	1 70
Female	1 65
Sockets (Chassis)	
Male	1 50
Female	2 35

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3½mm Mono	12p
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3½mm Metal Mono	20p

JACK SOCKETS

Chassis	
¼" Mono	20p
¼" Stereo	25p
2½mm Mono	15p
3½mm Mono	15p
Line	
¼" Mono	20p
¼" Metal	30p
¼" Stereo	30p
¼" Stereo Metal	40p
3½mm Mono	15p
3½mm Mono Line	20p

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(Post inc prices)

Towers Transistor Manual (Bible)	10 50
TTL Data	9.50
Data conversion	4.50
Volt Reg Data	3 95
Interface Data	3 95
Memory applic	4 95
Audio/Radio Hbk	4.50
Special function handbook	3 95

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All Metal

Plug	26p
Socket	26p
Line Skt	40p

3½ DIGIT LCD MULTIMETER

2 amps AC DC
1KV (DC)
750V (AC)
Incredible at
£34 50
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Provides a simple step-by-step introduction to the basic theory and application of digital electronics and gives clear explanations of the fundamentals of digital circuitry, backed up by experiments designed to reinforce this newly acquired knowledge. Supplied with an experimenter's PCB.

Price – UK £5.50
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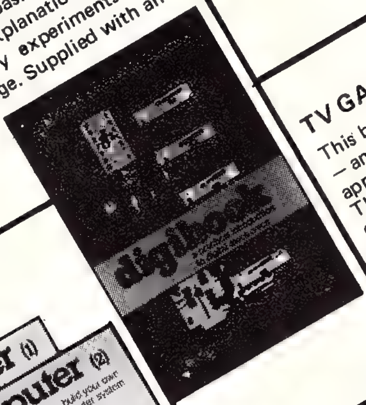

TV GAMES COMPUTER

This book, provides a different – and, in many ways, easier – approach to microprocessors. The TV games computer is dedicated to one specific task, as the name suggests. This provides an almost unique opportunity to have fun while learning!

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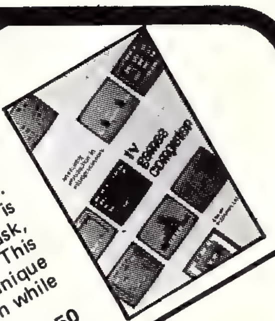

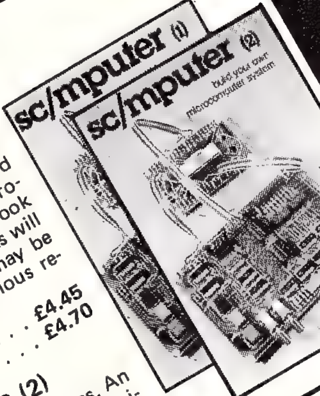

SC/COMPUTER (1)

Describes how to build and operate your own microprocessor system – the first book of a series – further books will show how the system may be extended to meet various requirements.

Price – UK £4.45
Overseas £4.70

SC/COMPUTER (2)

The second book in series. An updated version of the monitor program (Elbug II) is introduced together with a number of expansion possibilities. By adding the Elekterminal to the system described in Book 1 the microcomputer becomes even more versatile.

Price – UK £4.75
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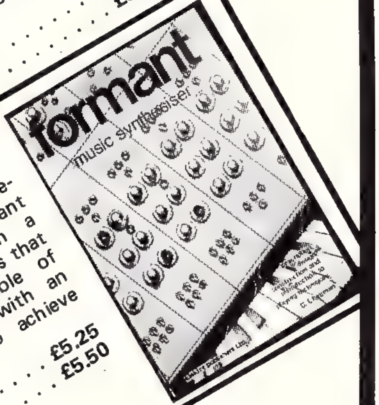

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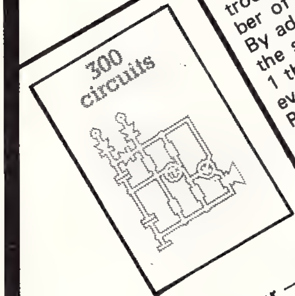

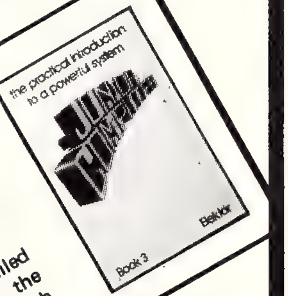

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JUNIOR COMPUTER BOOK 2

Follows in a logical continuation of Book 1, and contains a detailed appraisal of the software. Three major programming tools, the monitor, an assembler and an editor, are discussed together with practical proposals for input and peripherals.

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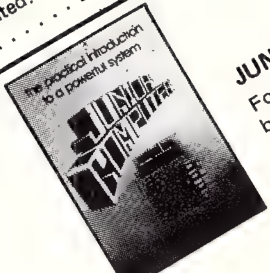
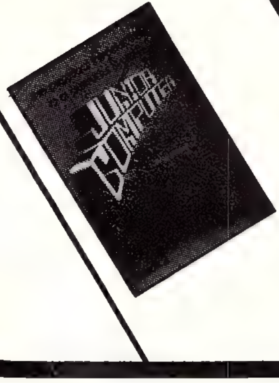
Price – UK . . . . £5.25. Overseas £5.50

JUNIOR COMPUTER BOOK 4

Book 4, the last in the series, describes all the software required to operate the complete system. A number of peripheral devices, such as a printer and a video terminal, may be 'hooked up' to the computer. During the final stage in its 'growth', the machine is able to extend its linguistic skills, for a special version of BASIC is now available on cassette. As a result, the Junior Computer is well and truly 'launched' as a fully fledged personal computer.

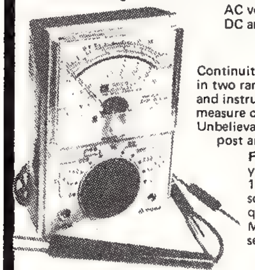
Price – UK . . . . £5.25 Overseas £5.50





When ordering please use the Elektor Reader's Order Card in this issue (the above prices include p. & p.)

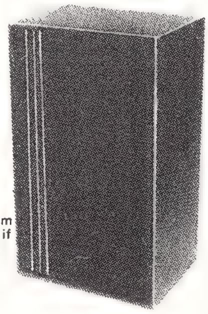
MINI-MULTI TESTER Deluxe pocket size precision moving coil instrument, Jewelled bearings - 2000 o.p.v. mirrored scale.
11 instant range measures: DC volts 10, 50, 250, 1000.
AC volts 10, 50, 250, 1000.
DC amps 0 – 100 mA.



Continuity and resistance 0 - 1 meg ohms in two ranges. Complete with test prods and instruction book showing how to measure capacity and inductance as well. Unbelievable value at only **£6.75 + 60p** post and insurance.

FREE Amps range kit to enable you to read DC current from 0 - 10 amps, directly on the 0 - 10 scale. It's free if you purchase quickly, but if you already own a Mini-Tester and would like one, send **£2.50.**

SUPER HI-FI SPEAKER CABINETS

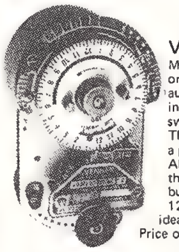


Made for an expensive Hi-Fi outfit – will suit any decor. Resonance free. Cut-outs for 6½" woofer and 2½" tweeter. The front material is Dacron. The completed unit is most pleasing. Supplied in pairs, price **£6.90** per pair (this is probably less than the original cost of one cabinet) carriage £3.00 the pair.

GOODMANS SPEAKERS

6½" 8 ohm 25 watt **£4.50.** 2½" 8 ohm tweeter. **£2.50.** No extra for postage if ordered with cabinets. Xover **£1.50.**

DITTO but for 8" speaker and 4" tweeter. **£7.50 + £3.50.**



VENNER TIME SWITCH

Mains operated with 20 amp switch, one on and one off per 24 hrs. repeats daily automatically correcting for the lengthening or shortening day. An expensive time switch but you can have it for only **£2.95.** These are without case but we can supply a plastic base **£1.75** or metal case **£2.95.** Also available is adaptor kit to convert this into a normal 24 hr. time switch but with the added advantage of up to 12 on/offs per 24 hrs. This makes an ideal controller for the immersion heater. Price of adaptor kit is **£2.30.**

THERMOSTAT ASSORTMENT

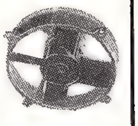
10 different thermostats. 7 bi-metal types and 3 liquid types. There are the current stats which will open the switch to protect devices against overload, short circuits, etc., or when fitted say in front of the element of a blow heater, the heat would trip the stat if the blower fuses; appliance stats, one for high temperatures, others adjustable over a range of temperatures which could include 0 – 100°C. There is also a thermostatic pod which can be immersed, an oven stat, a calibrated boiler stat, finally an ice stat which, fitted to our waterproof heater element, up in the loft could protect your pipes from freezing. Separately, these thermostats could cost around £15.00 -- however, you can have the parcel for **£2.50.**

50 THINGS YOU CAN MAKE

Things you can make include Multi range meter, Low ohms tester, A.C. amps meter, Alarm clock, Soldering iron minder, Two way telephone, Memory jogger, Live line tester, Continuity checker, etc. etc., and you will still have hundreds of parts for future projects. Our 10Kg parcel contains not less than 1,000 items - panel meters, timers, thermal trips, relays, switches, motors, drills, taps, and dies, tools, thermostats, coils, condensers, resistors, neons, earphone/microphones, nicad charger, power unit, multi-turn pots and data on the 50 projects.

YOURS FOR ONLY £11.50 plus £3.00 post.

EXTRACTOR FANS



Mains operated – ex-computer.
Woods extractor
5" – **£5.75**, Post £1.25
6" – **£6.95**, Post £1.25
5" Plannair extractor
£6.50. Post £1.25.
4"x 4" Muffin 115v.
£4.50. Post 75p.
4"x 4" Muffin 230v.
£5.75. Post 75p.

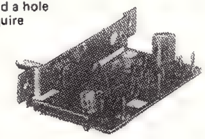
ROTARY WAFER SWITCHES

5 amp silver plated contacts. ¼" shaft. 1" dia. wafer.
Single wafer types, **29p each.** as follows:
1 pole 12 way   2 pole 6 way   3 pole 4 way
4 pole 3 way   6 pole 2 way   4 pole 3 way
Two wafer type, **59p each,** as follows
2 pole 12 way   4 pole 5 way   4 pole 6 way
6 pole 2 way   8 pole 3 way   12 pole 2 way
3 wafer types **99p each,**
9 pole 4 way   6 pole 5 way   6 pole 6 way
12p 3 way   18p 2 way

EXTRA POWERFUL 12v MOTOR

Made to work battery lawnmower, this probably develops up to ¼ h.p., so it could be used to power a go-kart or to drive a compressor, etc. etc. **£6.90 + £1.50 post.**
(This is easily reversible with our reversing switch - **Price £1.15**).

MINI MONO AMP on p.c.b., size 4"x 2" approx. Fitted volume control and a hole for a tone control should you require it. The amplifier has three transistors and we estimate the output to be 3W rms. More technical data will be included with the amplifier. Brand new, perfect condition, offered at the very low price of **£1.15 each, or 10 for £10.00.**

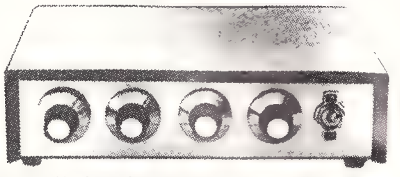


POPULAR PROVEN PROJECTS

MULTI-CHANNEL or ROBOT CONTROLLER

This is two kits. The 8 channel transmitter kit and the 8 channel receiver kit. Each kit comes with diagrams and notes, but no circuit boards, the component layout being left to you. The data shows how to drive, reverse and steer two or more motors. With spare channels to perform other functions. Price **£9.50 for both kits.**

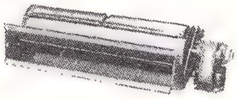
3 CHANNEL SOUND TO LIGHT KIT



Complete kit of parts for a three channel sound to light unit controlling over 2000 watts of lighting. Use this at home if you wish but it is plenty rugged enough for disco work. The unit is housed in an attractive two tone metal case and has controls for each channel, and a master on/off. The audio input and output are by ¼" sockets and three panel mounting fuse holders provide thyristor protection. A four pin plug and socket facilitate ease of connecting lamps. Special price is **£14.95** in kit form or **£25.00** assembled and tested. Case & metal Chassis No. Fully punched and prepared.

WHY BE COLD - Build a tangential blower heater.

TANGENTIAL BLOW HEATER



2.5 Kw quiet, efficient instant heating from 230/240 volt mains. Kit consists of blower as illustrated, 2.5 Kw element, control switch and data all for **£4.95.** post £1.50.

CAR STARTER AND CHARGER KIT

In an emergency you can start car off mains or bring your battery up to full charge in a couple of hours. The kit comprises: 250 watt mains transformer, 40 amp bridge rectifier, start/charge switch and full instructions. You can assemble this in the evening, box it up or leave it on the shelf in the garage, whichever suits you best. **Price £12.50 + £3.00 post.**

TRANSMITTER SURVEILLANCE

Tiny, easily hidden but which will enable conversation to be picked up with FM radio. Can be made in a matchbox – all electronic parts and circuit. **£2.30.**(not licenceable in the U.K.).

RADIO MIKE

Ideal for discos and garden parties, allows complete freedom of movement. Play through FM radio or tuner amp. **£6.90** complete kit. (not licenceable in the U.K.)

FM RECEIVER

Made up and working, complete with scale and pointer needs only headphones, ideal for use with our surveillance transmitter or radio mike. **£5.85.** or kit of parts £3.95.

3 - 30v VARIABLE VOLTAGE POWER UNIT

With 1 amp DC output, for use on the bench, students, inventors, service engineers, etc. Automatic short circuit and overload protection. In case with a volt meter on the front panel. Complete kit **£13.80.**

INTERRUPTED BEAM

This kit enables you to make a switch that will trigger when a steady beam of infra red or ordinary light is broken. Main components – relay, photo transistor, resistors and capacitors, etc. Circuit diagram but no case. **Price £2.30.**

IONISER KIT

Refresh your home, office, shop, work room, etc. with a negative ION generator. Makes you feel better and work harder – complete mains operated kit, case included. **£11.95** plus £2.00 post.

RADIO STETHOSCOPE

Easy to fault find – start at the aerial and work towards the speaker – when signal stops you have found the fault. **Complete kit £4.95.**

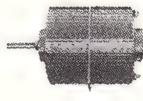
INVISIBLE AND SILENT SENTINEL

Ultra-sonic beam when broken could warn you of visitor – two kits – transmitter & receiver. To operate light or bell. **£9.50.**

BURGLAR ALARM

Complete kit includes 6" extrenal alarm bell, mains power unit, control box with keyswitch, 10 window/door switches, 100 yards of wire. With instructions. **£29.50.**

12v MOTOR BY SMITHS



Made for use in cars, these are series wound and they become more powerful as load increases. Size 3½" long by 3" dia. These have a good length of ¼" spindle – **price £3.45.**
Ditto, but double ended **£4.25.**

Ditto, but permanent magnet, **£3.75.**

WATERPROOF HEATING WIRE

60 ohms per yard, this is a heating element wound on a fibre glass coil and then covered with p.v.c. Dozens of uses – around water pipes, under grow boxes in gloves and socks. 23p a metre.

J. BULL (Electrical) Ltd.
(Dept. EL), 34 - 36 AMERICA LANE,
HAYWARDS HEATH, SUSSEX RH16 3QU.
Established 30 YEARS

MAIL ORDER TERMS: Cash, P.O. or cheque with order. Orders under £10 add 60p service charge. Monthly account orders accepted from schools and public companies. Access & B/card orders accepted day or night. Haywards Heath (0444) 454563. **Bulk orders:** write for quote. Delivery by return. Shop open 9.00 — 5.30, mon to Fri, not Saturday.

SC
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LIGHTING &

Copper clad. PVC she
1.5mm single
1.5mm flat twim
1.5mm flat 3 core & E
4mm single
6mm flat 3 core
16mm flat twin & E
Telephone and multiway cables.
15 core per
10 core per 2

THERMOSTATS & HEAT S

Thermostat. 3 level contact type . .
10 amp appliance type thermostat. Spindle
Contact type with changeover, 10 amp swit
Wall mounting, metal case, c/o contacts low £2.30

TIMERS & CLOCKSWITCHES

Time and Set Switches. Smiths, Glass fronted 25 amp, 230v	£2.30
24 Hour time switch. 100 amp Smiths and clockwork reserve. Ex-Electricity Company	£5.50
Cooker clock switch. Smiths 12 hour	£1.00

Clockwoek operated switches.
15 amp, 230v. On time up to:

10 minutes	£1.37	120 minutes	£1.37
30 minutes	£1.37	360 minutes	£1.37

OMRON mini-timer, ref. STP NH	£3.50

BLEEPERS - SIRENS - BELLS - BUZZERS

Siren/Hooter – Delta 6 or 12v DC or 24v AC	.37
Open type buzzer, ex GPO, 10 - 20V	.30
Underdome bell, 4v - 9v	.85
Fire alarm bell, 12" gong, heavy cast iron construction	£12.00

COUNTERS

6 digit counter. Mains operated. Not resettable	.60
Ditto, But even numbers only	.50
6 digit counter. 48v DC, 115v AC. Resettable	£1.00

SWITCHES - ROCKER, TOGGLE, ETC.

Rocker switches: white push into hole 1" x 7/16". All rated

10 amp, AC 250 volt.	on/off	.12
	changeover centre off	.15
	on/off with neon	.30
	push to make spring return	.20
	push to break spring return	.20
Larger two circuit one on one with mounting plate		.20
13 amp rocker switch. Car Fastener (DoT)		.15
Pistol Grip Switch: with lock-on as in electric drills		.30
Interlocking switch: blow heater, 3 rockers, 10 amp		.30
Micro switches. V3 types. 10 amp c/o contacts		.20
mains button operated:	15 amp c/o contacts	.25
	10 amp off/on	.15
	15 amp off/on	.20
	Lever operated add	.10
	Lever with roller operation add	.15
Miniature types: Burgess V4T6 c/o		.30
Two mounted with roller operator		.65
Glass reed switches:	60 watt **10p.** 40 watt **5p.**	
	flat multi stackable 60 watt	.50
Operating coils for reed switch multi voltage 3, 6, 9, or 12		.50
Ceramic magnets	Mullard	.10
Mini Magnet		.15

MISCELLANEOUS ITEMS

Neon Mains indicators.	Standard	.15
	Extra small	.25
Bench isolation mains in 230/240v output. 250 Watts		£4.50
Mains input. Porcelain removable fuse		.20
Light operated switch 12 volt. Encapsulated		£1.25
Insulating board. srbp etc. Approx 10 tons. Sheet size 4'x 4' or larger. Various thicknesses. price per lb.		.50
Ditto, Tufnol, price per lb.		£2.00
Aerosol can ICI Fluon lubricant		.35
Varicap P.B. TV tuner		.50
Battery holder takes 6 U2 batteries, snap connector		.25
Car Battery clips, as for charger, + and –. per pair		.10

MAINS TRANSFORMERS

6 volt 1 amp	.50	35 volt 2 amp	£2.00
6.3 volt 2 amp	£1.00	38 volt 2½ amp	£2.50
12 volt ¾ amp	.75	26 volt 10 amp	£4.00
12 volt 4 amp	£2.00	50 volt 2 amp	£2.00
12 volt 1 amp	£1.00	12 - 0 - 12, 2 amp	£2.50
8.5 - 0 - 8.5 1 amp	£1.00	12 - 0 - 12, 1 amp	£2.00
18 volt 1 amp	£1.50	100W auto 115v o/p	£2.00
25 volt 1½ amp	£1.50		

MOTORS - MAINS & BATTERY

3 - 6 volt battery motor, very small		.15
3 - 12 volt battery motor, very low current		.20
Mains motor with gear box	5 rev minute	£2.25
	80 rev per minute	£3.00
	110 rev minute	£2.00
	200 rev minute	£1.50
Mains motor, double ended fan motor		£1.20
Ditto	single ended fan motor	£1.00
Fan blade for above		.50
Mains motor, double ended, very powerful 1½" stack		£1.50
Mains instrument motors with gear box:	1 rev 24 hours	£1.50
	1 rev 1 hour	£1.50
	16 rev minute	£1.50
	4 rev minute	£1.50
	2 rev minute	£1.50
	1 rev minute	£1.50
Motor clockwork, set up to 1 hour		.38
Motor, clockwork set up to 1 hour with ringer		.75
Mains motor ¼ h.p. 1425 revs, ex-computer		£4.25
Vent opening motor with end stop switches		£12.50
12 volt motors, Smiths, single ended ¼" spindle		£1.50
12 volt motors, Smiths, double ended ¼" spindle		£2.00
12 volt motors, P magnet type, single ended		£1.75
1½ h.p. motor 3450 rpm 100 volt. 50Hz. New		£5.00

SPECIAL TERMS. For items in this column. Order no less than 10 of any item. Then add VAT at 15%, and 20% for carriage in the case of transformers and electric motors. All other items in this column are free post & packing.

high quality, very reliable, industry standard ves These can be used as single sided/single ity, double sided/double density or double sided/ uble density depending on the host computer disk interface. Compatible with most micro-computers e.g VIDEO GENOE, ATOM, TRS 80, BBC COMPUTER, SUPER BRAIN, NASCOM etc. etc. If used as double sided/double density then the storage capacity is 3.5 MAGABITS/DRIVE (unformatted), track density is 48 TPI and can daisy chain up to 4 drives 90 day warranty

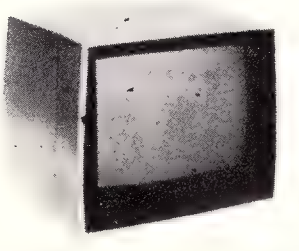
One disk drive only	**£179 + VAT = £205.85**
Two disk drives	**£349 + VAT = £401.35**
Single boxed with power supply	**£214 + VAT = £246.10**
Dual boxed with power supply	**£389 + VAT = £447.35**
2 Drive Cable	**£15 + VAT = £17.25**
DS/DD 48 TPI diskettes	**£2.50 + VAT = £2.88**

MITSUBISHI
Double sided/double density Double Tracks ¼" Disk Drives

This is the latest addition to our range of disk drives. The capacity is 1 MAGA BYTES (unformatted) per drive, the track density is 96TPI. Track to track access time is 3 msec. These are compatible with Shugart SA460 (ANSI standard interface). Compatible with BBC COMPUTER, ATOM, NASCOM and lots of other computers.

One disk drive only	**£219 + VAT = £251.85**
Two disk drives	**£429 + VAT = £493.35**
Single boxed with power supply	**£249 + VAT = £286.35**
Dual boxed with power supply	**£459 + VAT = £527.85**
DS/DD 96TPI diskettes	**£3.95 + VAT = £4.54 each**

PROFESSIONAL MONITORS



- **GREEN MONITOR** 12" green monitors with composite and sync input. Suitable for most computers

Hitachi MM1216	£89 + VAT = £102.35
SM12H 18 MHz monitor	£89 + VAT = £102.35
SM12N 15 MHz monitor	£69 + VAT = £ 79.35

- **COLOUR MONITORS** 14" colour monitors, RGB or composite and sync input

SCM14N Normal-res 400 dots	**£199** + VAT
SCM14M Medium-res 600 dots	**£339 + VAT**
SCM14H High-res 800 dots	**£499 + VAT**

TI99/4A SOFTWARE

SOLID STATE SOFTWARE MODULES *

*TI-Invaders	**£15 + VAT = £17.25**
*Video Games 1	**£18 + VAT = £20.70**
*Mind Challengers	**£10 + VAT = £11.50**
*A-Maze-ing	**£18 + VAT = £20.70**
*Connect Four	**£18 + VAT = £20.70**
*Soccer	**£18 + VAT = £20.70**
*Tombstone City	**£18 + VAT = £20.70**
*Zero Zap	**£18 + VAT = £20.70**
*Attack	**£18 + VAT = £20.70**
*Blasto	**£18 + VAT = £20.70**
*Hustle	**£18 + VAT = £20.70**
*Yahtzee	**£18 + VAT = £20.70**
*Black Jack/Poker	**£18 + VAT = £20.70**
*Car Wars	**£22 + VAT = £25.30**
*Munchman	**£22 + VAT = £25.30**
*Chess	**£28 + VAT = £32.20**
*Adventure & Pirate	**£28 + VAT = £32.20**
·Mini memory	**£60 + VAT = £69.00**
·PARSEC	**(please telephone)**

ADDITIONAL ADVENTURE PROGRAMS *

(Use with Adevnture Module)

*Adventure Land	**£18 + VAT = £20.70**
*Mission Impossible	**£18 + VAT = £20.70**
(Voodoo Castle	**£18 + VAT = £20.70**
*The Count	**£18 + VAT = £20.70**
*Strange Odyssey	**£18 + VAT = £20.70**
*Mystery Fun House	**£18 + VAT = £20.70**
*Pyramid Fun House	**£18 + VAT = £20.70**
*Ghost Town	**£18 + VAT = £20.70**
*Savage Island I & II	**£22 + VAT = £25.30**
*Golden Voyage	**£18 + VAT = £20.70**

A lot more Software is available S.A.E. for list.

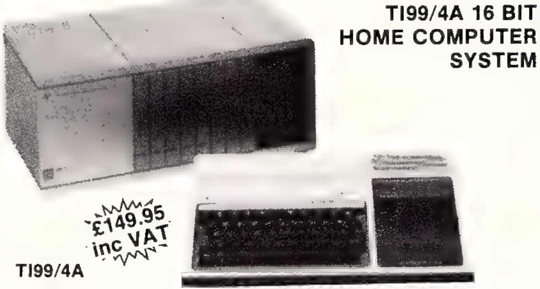
BBC MICROCOMPUTER

BBC Microcomputer Model B	£348 + VAT = £399
Mode B + Econet Interface	£389 + VAT = £446
Model B + Disk Interface	£409 + VAT = £469
Model B + Econet + Disk Interfaces	£450 + VAT = £516
Singe disk drive (100K)	£230 + VAT = £264
Torch Dual Disc Drive (800K) with Z80 Processor 64K of RAM and CPN operating system	£779 + VAT = £895
Parallel printer cable	£ 12 + VAT = £103
Games Paddles (per pair)	£11 + VAT = £12.65

SOFTWARE FOR BBC COMPUTER

Desk Diary (Two programmes)	**£8.65 + VAT = £9.95**
Algebraic manipulation package	**£8.65 + VAT = £9.95**
BBC Peeko Computer	**£8.65 + VAT = £9.95**
BBC FORTH language	**£14.50 + VAT = £16.67**
BBC LISP language	**£14.50 + VAT = £16.67**
BBC word processing package	**£52 + VAT = £59.80**
Printer Driver Cass	**£8.65 + VAT = £9.95**

TEXAS INSTRUMENTS TI99/4A 16 BIT HOME COMPUTER SYSTEM



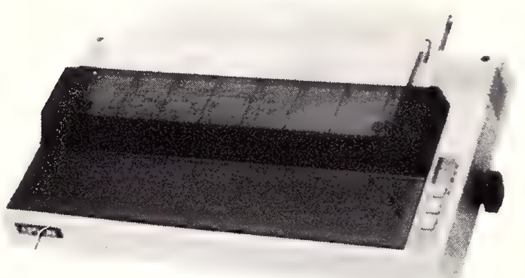
TI99/4A

This microcomputer is based on TMS9900 16 bit microprocessor. It includes 16K RAM, 16 colour high resolution graphic (192x256) The screen display is 32 characters, 24 lines TI-BASIC. Full size keyboard. For Software there are about 1000 Programs to choose from. There are a lot of peripherals available e.g. Disk Drives, Disk Interface, Speech Synthesizer, Extra RAM. Additional Languages (PASCAL, TI-LOGO, ASSEMBLER). **Prices:** TI Home Computer **£149.95;** Peripheral Expansion System **£134.95;** Disk Controller Card **£124.95;** Disk Drive **£199.95;** Speach Synthesiser **£41.95.** All prices inclusive of VAT. Please send large SAE for full price list.

GUARANTEED LOWEST PRICES

We guarantee that our prices are the lowest on the market. If you can find any item advertised and in stock at less than our price we will match that price.

NEW EPSON TYPE 3 PRINTERS



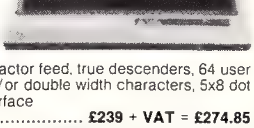
MX80 F/T-3

80 column, 80 CPS, super and subscripts, auto underlining, tractor feed, 32 print fonts. Bi-directional printing, logic seeking, 9 x 9 matrix, high res. graphics, centronic parallel interface, tractor or friction paper feed. FREE 500 sheets of paper .... **Price: £325 + VAT = £373.75**

MX 100-3

136 columns, 100 CPS, all other features of MX80 plus true descenders, adjustable paper width up to 15 inches, friction or tractor feed, centronic parallel interface. .... **Price: £429 + VAT = £493.35**

SEIKOSHA GP SERIES PRINTERS WITH HIGH RES. GRAPHICS



GP-100A 50 CPS, 80 column, Hi-res graphic line repeat function, adjustable up to 10" paper width, tractor feed, 5x7 dot matrix

GP-100A centronic parallel interface	**£189 + VAT = £217.35**

GP-250X New 50 CPS, 80 column, tractor feed, true descenders, 64 user defined characters, double height and/or double width characters, 5x8 dot matrix, parallel and serial (RS232) interface

GP-250X	**£239 + VAT = £274.85**

CORDLESS PHONES

Not licensible in UK

Prices from £79.35 inc. VAT for the model shown on the left.

LONG RANGE TELEPHONE

This is a long range (2-5 miles) cordless extension phone with intercom facility between portable hand set and the base station. You can receive all incoming calls and dial out to anywhere in the world from the hand set from any location within 5 mile radius of your home or office. The maximum range is achieved by using roof top optional antenna (not included).

Long range extension phone	**£249 + VAT = £286.35**
Optional rooftop antenna	**£45 + VAT = £51.75**

MEDIUM RANGE TELEPHONE

Similar specifications to the above model but with operational range of ½ mile to 2½ miles (with rooftop antenna)

Medium range extension phone	**£189 + VAT = £217.35**
Optional rooftop antenna	**£ 45 + VAT = £ 51.75**

SHORT RANGE TELEPHONE

This is a short range cordless telephone for use within the house or from the garden. You can receive and make calls from the hand set. Range approx. 600 feet

Short range telephone	**£69 + VAT = £79.35**

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This is an individually coded 4 WATTS Radio transmitter and pocket pager receiver. The alarm system has connectors for door contacts and vibration sensors 2 vibration sensors are included It has a range of 2 miles Ideal for protection of vehicle or property. Power requirements for transmitter is 12V dc Not licensible in UK

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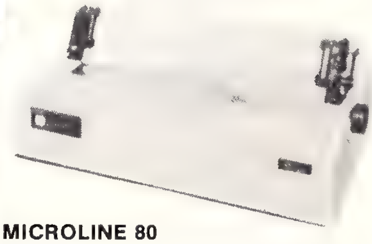

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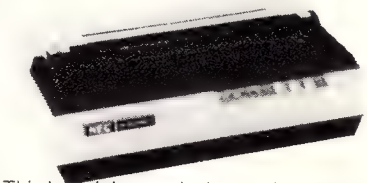

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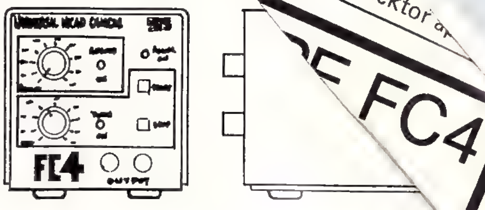

Power requirement	: 240 V AC 60 Watts.
Constant current generator	: Variable from 10 mA to 4 amps, Log Scale. 'Regulation OK' lamp extinguishes on too high a load.
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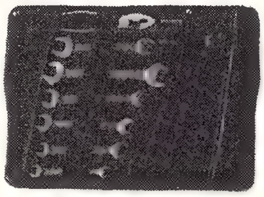

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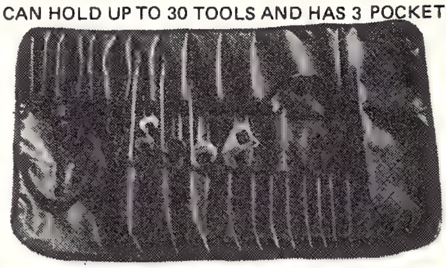

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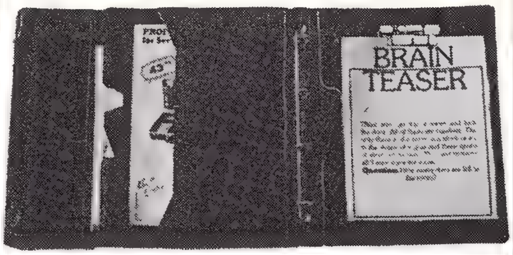

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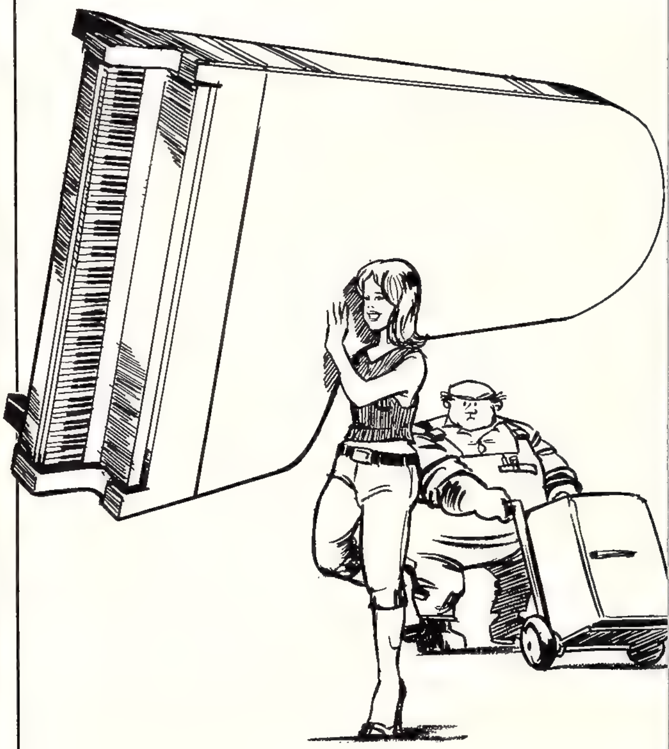

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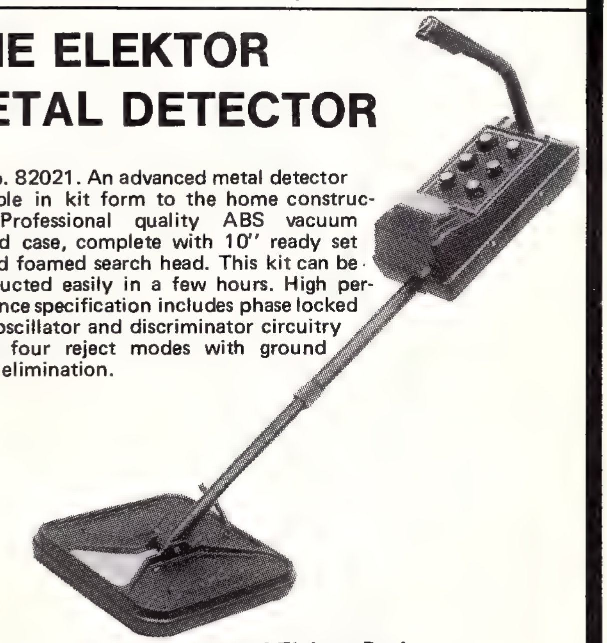

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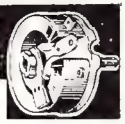

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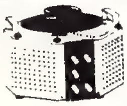

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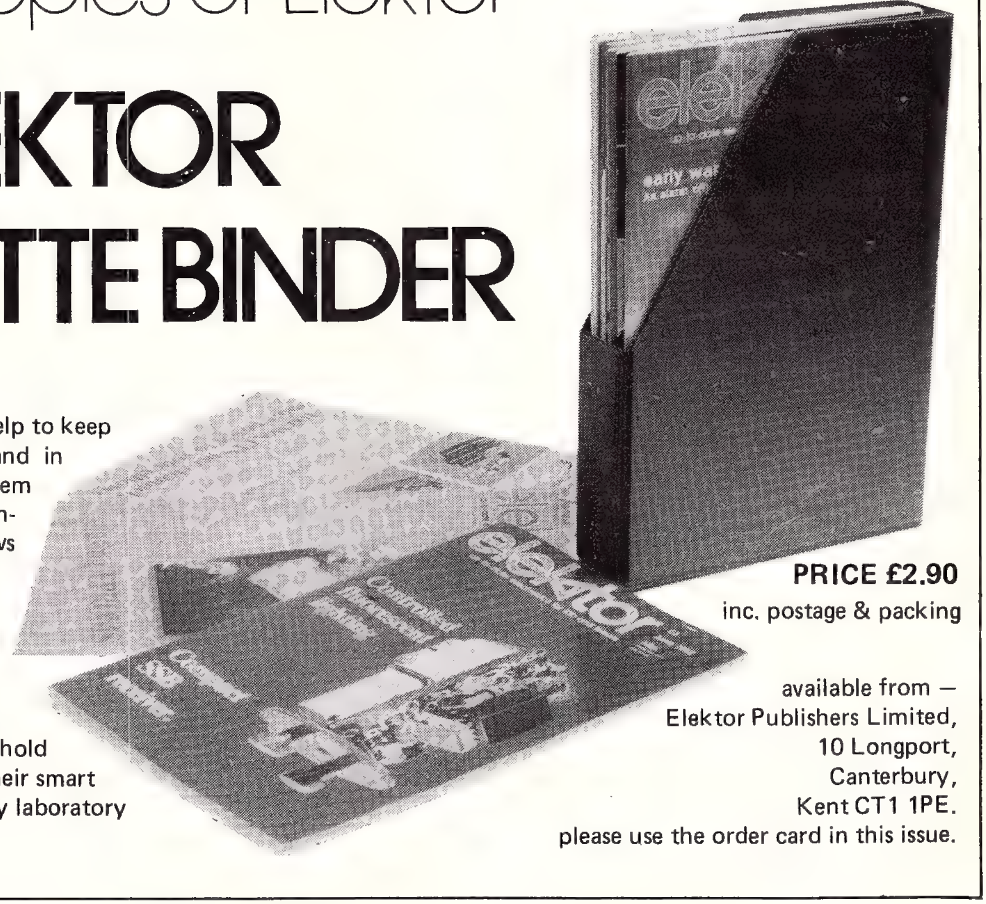

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ps-service

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Example:
digisplay (E13) 9376 3.25 7.25
1 2 3 4 5

1. Circuit title
2. reference to associated article(s)
3. board number
U.K.:
4. price (in £) inclusive of 15% VAT
U.S.A. and Canada:
5. price in $, not including tax (if any)

		£	$
E26: JUNE 1977			
formant: keyboard interface (E25)	9721-1	4.20	8.50
E29: SEPTEMBER 1977			
formant (E25, E26):			
interface receiver	9721-2	1.80	3.50
power supply	9721-3	6.90	13.75
keyboard divider (one octave)	9721-4	1.65	3.25
E33: JANUARY 1978			
simple function generator	9453	4.05	8.—
E36: APRIL 1978			
formant (E25 . . . E35):			
COM	9729-1	5.05	10.—
elektornado	9874	4.45	9.—
E42: OCTOBER 1978			
VHF/UHF modulator	9967	1.95	4.—
E43: NOVEMBER 1978			
ASCII keyboard	9965	9.65	19.25
E44: DECEMBER 1978			
elekterminal	9966	9.40	18.75
E48: APRIL 1979			
UHF/VHF modulator (see E42, October 1978)	9967	1.95	4.—
E53: SEPTEMBER 1979			
parametric equaliser,			
filter section	9897-1	2.05	4.—
tone control section	9897-2	2.05	4.—
E55: NOVEMBER 1979			
topamp	80023	1.80	3.50
E56: DECEMBER 1979			
steam train	80019	2.35	4.75
E58: FEBRUARY 1980			
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bus board 2	80068-2	6.—	12.—
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supply board	80068-5	3.60	7.25
E59: MARCH 1980			
chorosynth	80060	27.70	55.50
E60: APRIL 1980			
aide-de-camp: 12 V/2 A	7043B	1.40	2.75
E61: MAY 1980			
Junior Computer:			
main board	80089-1	15.75	31.50
display board	80089-2	1.65	3.25
supply board	80089-3	3.80	7.50
E63/64: SUMMER CIRCUITS 1980			
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E65: SEPTEMBER 1980			
8K RAM + EPROM card	80120	16.45	33.—
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voiced/unvoiced detector			
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E72: APRIL 1981			
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intelekt	81124	7.05	14.—
universal power supply	81128	3.05	6.—
E74: JUNE 1981			
Junior Computer			
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−12 V supply	81033-2	1.80	3.50
adaptor board	81033-3	1.60	3.25
E75/76: SUMMER CIRCUITS 1981			
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'hi-fi' siren	81525	2.40	4.75
hi-fi preamplifier	81570	5.40	10.75
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E77: SEPTEMBER 1981			
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DFM + DVM	81156	5.35	10.75
revolution counter	81171	6.10	12.25
digital barometer	81173	4.40	8.75
E78: OCTOBER 1981			
EPROM programmer	81594	1.80	3.50
wide range dark room timer	82004	2.80	5.50
shutter speed meter	82005	4.70	9.50
LCD panel meter	82011	2.05	4.—
E79: NOVEMBER 1981			
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keyboard section	82001-3	3.90	7.75
sine-wave oscillator	82006	2.60	5.25
telephone amplifier	82009	1.90	3.75
power supply	9968-5A	1.75	3.50
mini organ	82020	4.40	8.75
metal detector	82021	7.05	14.—
LCD frequency counter	82026	2.50	5.—
high boost	82029	2.35	4.75
E80: DECEMBER 1981			
70 cm transverter (Oct.)	80133	15,65	31,25
VHF/UHF converter board	9864	2,20	4,50
IPROM	82019	2.05	4.—
synthesiser VCO	82027	5.50	11.—
flashing light	82038	2.—	4.—
capacitance meter module	82040	2.50	5.—
E81: JANUARY 1982			
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E82: FEBRUARY 1982			
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E83: MARCH 1982			
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synthesiser power supply	82078	4.60	9.25
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E84: APRIL 1982			
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E85: MAY 1982			
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prop-tachometer	82116	2.65	5.25
E86: JUNE 1982			
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solid state relay	82131	1.95	4.—
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E87/88: SUMMER CIRCUITS 1982			
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D/A converter	82112	2.40	4.75
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light-sensitive switch	82528	2.—	4.—
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slave flash	82549	1.85	3.75
5 V power supply	82570	2.75	5.50
E89: SEPTEMBER 1982			
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darkroom computer part I			
keyboard	82141-1	4.65	9.25
keyboard interface	82141-2	2.50	5.—
display	82141-3	2.80	5.50
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main board	82147-1	3.75	7.50
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TV games:			
'rapid loader'	82558-1	4.30	8.50
EPROM plug-in board	82558-2	2.45	5.—
E90: OCTOBER 1982			
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process timer	82142-3	2.50	5.—
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R.F. board	82144-1	2.—	4.—
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wave shifter for SSB:			
low frequency converter	82161-1	2.55	5.—
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E91: NOVEMBER 1982			
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E92: DECEMBER 1982			
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precision power supply	82178	5.05	10.—
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E93: JANUARY 1983			
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E94: FEBRUARY 1983			
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Prelude			
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power supply	83022-8	4.65	9.25
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E95: MARCH 1983			
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Prelude			
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NEW

E96: APRIL 1983			
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Prelude			
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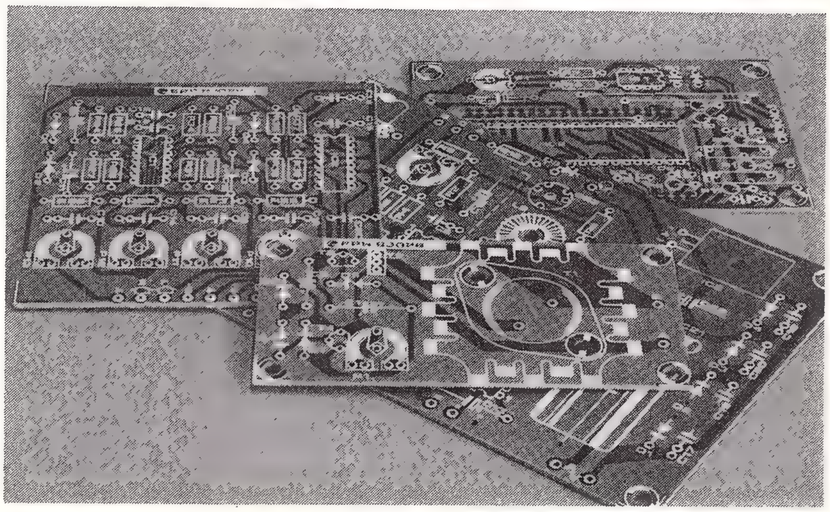

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Elektor Artist (E85)	82014-F	2.60	5.25
precision power supply (E92)	82178-F	2.35	4.75
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NEW

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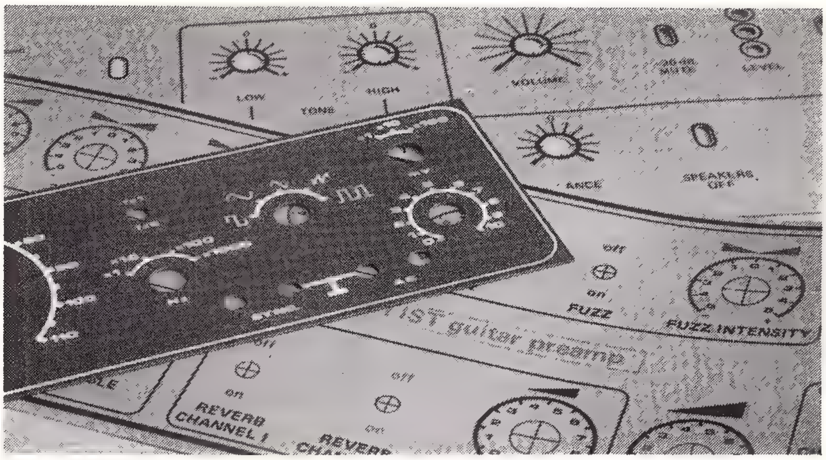

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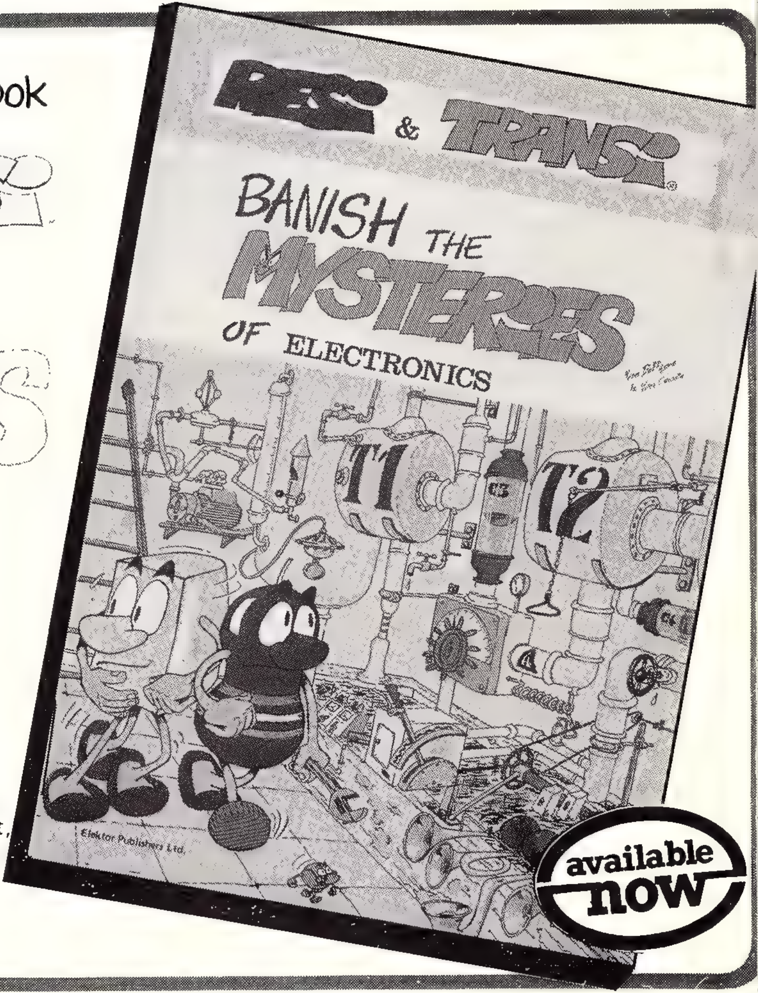

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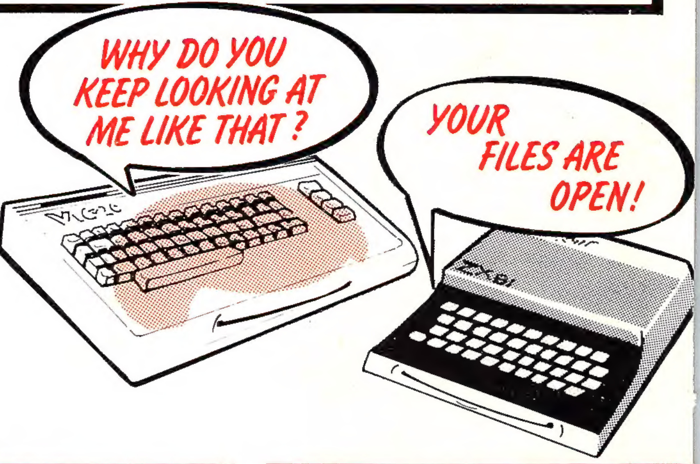
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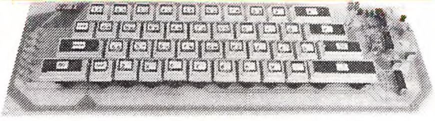

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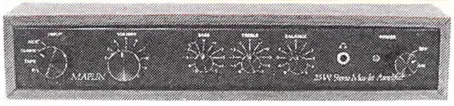

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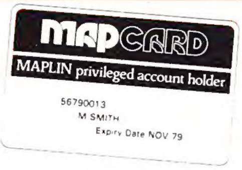

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